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Bulletin 68

ENTOMOLOGY 18

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AQUATIC INSECTS IN NEW YORK STATE

A study conducted at the entomologic field station, Ithaca N. Y. under the direction of
EPHRAIM PORTER FELT D.Sc.

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New York State Museum

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Bulletin 68

ENTOMOLOGY 18

AQUATIC INSECTS IN NEW YORK STATE

PREFACE

It is very gratifying to present the public with such a material addition to our knowledge of the aquatic insects of the State, an ecological group which has received almost no attention except from those engaged in a systematic study of the adults. There is no doubt that insects form an important part of the sustenance of some of our most valued food fishes, as shown by Dr Needham's studies of the food contents of trout stomachs. Mr Johannsen's systematic and biologic study of these minute species will do much toward making possible their identification in the immature as well as the adult condition. The ability to identify young or immature forms is exceedingly important when studying aquatic insects, and the great attention given to the early stages is the most valuable feature of this collection of papers. The publication of this bulletin marks another important step in an investigation on the value of insects as fish food. The consummation of this, as has been previously pointed out, is a work of years; and it is hoped that each season may be marked by substantial progress.

The acquisition of new facts is a laborious process; and the several authors are to be congratulated on their success.

This collection of papers will prove not only a source of information but also an inspiration to all subsequent workers.

E. P. Felt
State Entomologist

Part 1

STATION WORK OF THE SUMMER OF 1901

BY JAMES G. NEEDHAM

In 1901 the entomologic field station was conducted at Ithaca. The results of extensive field work at Saranac Inn the preceding season had not been fully worked up, and it seemed desirable that this unstudied material should be reported on. Thus access to collections and libraries became desirable; therefore, when Professor Comstock generously offered the station working quarters in his laboratory at Cornell University and the use of his library, his offer was gladly accepted.

A less ambitious program of field work was arranged for this second season. But, on the other hand, systematic studies of more importance and value, were planned and successfully carried out. The field work of the season was directed toward the study of nematocerous Diptera, aquatic Coleoptera and the aquatic neuropteroid groups. Breedings of Odonata-Zygoptera were carried on in order to supplement the extensive collections made at Saranac Inn in 1900, and to furnish a better basis for the account of that group in this bulletin. Not many additional species were reared, but much valuable material was obtained for some of the species there insufficiently studied. Trap lantern and other miscellaneous collecting was done through the season. In addition to the breedings of nematocerous Diptera, conducted by Mr O. A. Johannsen with great diligence and success, numerous Perlidae and Ephemeridae were reared by Mr Betten and myself. Collections of aquatic Coleoptera were also made, and these, together with my own breedings in that group, Mr. Mac Gillivray has worked up, generously adding thereto previous unpublished breedings of his own. His account of the group published herewith is destined to be highly useful to students of aquatic insects.

The chief feature of the station work of this season was cooperation. The station and the entomologic laboratory of Cornell University worked together most agreeably. Common use was had of the equipment of both. In addition to the studies made for us by Mr MacGillivray, Professor Comstock assigned two of his graduate students, Mr O. A. Johannsen and Mr K. C. Davis, to work on special groups which the station was desirous of having investigated; and their work, published herewith, speaks for itself. This arrangement has made it possible to present now a larger body of work than the station independently, on its own limited resources, could have secured.

The station sacrificed nothing in natural advantages by removal to Ithaca. While so little is known of aquatic insects, the fauna of one place is about as new as that of another. For biologic field work of any sort, Ithaca possesses very great advantages. It would be hard to find a place with more variety of situation easily accessible. This is nature's contribution; and it is, of course, the first requisite of a field station. It rarely happens that so rich and varied a fauna and flora lie at the very doors of the laboratories in which their study may be most advantageously carried forward.

East hill, with the university campus spread out on one of its terraces, has cool swamps at its head and the Renwick flats and Cayuga lake at its foot, and is seamed all down its front by narrow gorges cut by turbulent streams. Across the narrow valley West hill rises with like abruptness; but it is of more regular contour, and its upper, gentler slopes are checkered by farms. Between the two hills at the head of the lake is a marshy flood plain, partly timbered, and traversed by sinuous creeks and bayous. Sheltered behind the present natural embankment of the lake is the Renwick lagoon, characteristic views of which are shown in plates 1, 2 and 20. This is a great natural aquarium, teeming with plant and animal life. It is also a natural foraging ground for many of the lake fishes.

The open lake is but a stone's throw to the northward, and the lagoon opens directly into one of the several nearby creeks. Plates 3 and 32 show situations along two of the creeks of East hill near the university campus and 600 feet above the lake level. These are pictures of collecting grounds utilized in gathering material for the present report. They give but a scant idea of the great variety and picturesqueness of these streams. Within easy walking distance of the campus are streams of all degrees of swiftness and of all sizes from the large creek to the tiny rivulet. The two creeks that bound the campus on the north and on the south, flow gently in their upper reaches and again on the flats below, but they descend the steeps of East hill in a succession of cascades.

The workers at the station who were more or less directly participating in its operations were the following:

1 Professor C. Betten, of Buena Vista College, Ia., special collector of Trichoptera for the Cornell University collection. Rearing caddis flies and stone flies and running trap lanterns for the station.

2 Mr O. A. Johannsen of Cornell University, graduate student in entomology. Collecting and rearing nematocerous Diptera.

3 Mr A. D. MacGillivray, instructor in entomology in Cornell University. Studying aquatic Coleopterous larvae.

4 Mr H. N. Howland of Lake Forest College. Studying Odonata, and experimenting with apparatus for quantitative collecting of the insects of shore vegetation.

5 Mr H. D. Reed, instructor in vertebrate zoology in Cornell University. Collecting and studying aquatic insects and fish food.

6 Mr T. L. Hankinson of Cornell University. Studying and collecting the same.

7 Myself, in charge of station operations.

The excellent companionship of this body of enthusiastic students, the satisfactory and regular progress of daily routine, the fine facilities of the laboratory, the rich library, the accessibility of good collecting grounds, the suitableness of the equipment of the station, the beauty of the environment, and the weekly diversion of the meetings of the *Jugatae*[1] made the session one long to be remembered. Its work was done under exceptionally pleasant circumstances.

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[1] Entomologic Club of Cornell University.

The results of our work in so far as made ready for publication appear in the following pages. With the aid of Messrs Reed and Hankinson, I have studied the food of the 25 brook trout taken in Bone pond at Saranac Inn, as detailed in my first report [N. Y. State Mus. Bul. 47, p. 396], and now report on it. The food of these trout was almost wholly insects, and there was found such a preponderance of a single species of gnat larva (family Chironomidae, order Diptera) in the food, as indicates that that species may prove of high economic importance in water culture. In another brief article I have brought together the descriptions of a few dipterous larvae of unusual types. Most interesting, perhaps, is the larva of Epiphragma fascipennis, a burrower in fallen willow and buttonbush stems, lying on the banks of temporary ponds; a larva of enforced amphibious habits, its residence sometimes submerged, sometimes exposed; and it has a mode of respiration suited to either condition. My chief contribution to this bulletin is the description of the life histories and habits of the damsel flies (order Odonata, suborder Zygoptera). I have been able to describe the nymphs of all our 10 genera and of 23 of our 42 known species, all these descriptions being new.

Mr MacGillivray has prepared a table of families of coleopterous larvae in general that will be of great assistance to students of this order. His careful study of the respiratory apparatus of the Donacia larva solves the old, troublesome problem as to how that animal, dweller on the submerged roots of water plants, gets its air. His study of Donacia is complete for all species of the world fauna now known as larvae, and a considerable proportion of them are now described for the first time.

Mr Johannsen introduces his study of the dipterous families, Blepharoceridae, Simuliidae, Dixidae, Culicidae and Chironomidae, with a table of families of nematocerous diptera. His account of the Simuliidae is a monograph of the species of the eastern United States in all stages of their development. In the Dixidae he gives a key to our species (imagos) and offers the first life history written for an American species. His treatment of Culicidae is a generic synopsis of the family—and much more; for he tabulates our known species of each genus, except Culex. His careful and complete treatment of the Corethriinae is specially gratifying because this subfamily has been neglected by other American students of Culicidae. In the Chironomidae, that Chironomus which is the chief article of diet for brook trout in Bone pond [*see* pt 2] is treated as completely as possible. Life histories are offered in two genera new to our fauna. This is but the beginning of Mr Johannsen's work on the Chironomidae.

Dr Davis's paper is a monograph of the Sialididae of America, and will be of great service to students of this neuropterous family, since it brings together descriptions of all known American species with an account of what is known of their life histories.

There remain, of station material still to be reported on, some Chironomidae and a large number of bred Perlidae and Ephemeridae.

Part 2

FOOD OF BROOK TROUT IN BONE POND

BY JAMES G. NEEDHAM

I have already given in New York State Museum bulletin 47, page 395-96, a brief statement of the conditions under which there were obtained from Bone pond during the summer of 1900 the stomach contents of 27 brook trout for study. These trout were all taken with hook and line. They were all adults and had selected their food in the natural way from what the pond offered.

The pond itself is a small natural body of water less than 300 meters in greatest diameter and nearly circular. It is without outlet and is surrounded by deep woods. I have given a brief sketch of its shore vegetation in bulletin 47 on page 389-90, with mention of the commoner animals collected there. It contains no fish but the brook trout. It was artificially stocked years ago, and has been repeatedly replanted with fry. Of the three propagating ponds controlled by the Adirondack Hatchery, it is by far the most successful in trout production. From the beginning the trout have been able to maintain themselves in large numbers. Most of the trout I saw taken from it in 1900 were rather lean, though otherwise in good and healthy condition, and suggested that possibly it was becoming overstocked.

Of the 27 stomachs obtained, one was empty, and the contents of another were lost through the breaking of a bottle, leaving 25 for study. I give below in tabular form a bare statement of what these 25 had eaten, and follow it with an account of what has been learned elsewhere of the biology of the insects constituting their food.

Table showing the stomach contents of 25 brook trout from Bone pond

Number	Date	Chironomus sp.? larva	Chironomus sp.? pupa	Corethra sp.? larva	Corethra sp.? pupa	Trichopter larva	Trichopter pupa	Trichopter cases	Aeschna constricta	Callibaetis sp.? nymph	Atax crassipes	Daphnidae	Miscellaneous
1	28 July	6	....	....	3	....	....	....	....	....	2	....	....
2	30 "	124	....	5	2	1	....	11	....	1	....	....	....
3	3 Aug.	14	2	....	....	2	....	44	....	....	....	....	....
4	3 "	7	....	....	....	....	....	....	....	....	....	....	....
5	3 "	235	....	42	....	....	....	....	....	....	....	fragments	....
6	3 "	313	1	....	20	1	....	1	....	....	....	....	....
7	3 "	15	340	....	....	2	....	5	....	....	....	....	*a*
8	3 "	77	2	5	....	....	....	....	....	1	....	....	....
9	3 "	7	....	1	12	1	....	5	....	....	....	....	*b*
10	3 "	114	....	1	3	....	....	....	1	....	....	....	....
11	3 "	36	32	3	2	....	...	....	....	....	....	....	*c*
12	3 "	9	1	1	....	....	....	....	....	....	....	....	....
13	3 "	2	....	1	4	....	....	....	....	1	....	....	....
14	3 "	5	58	....	....	....	3	....	....	....	1	....	*d*
15	3 "	351	....	....	4	....	1	....	....	....	....	....	....
16	3 "	......	....	....	....	1	....	....	....	2	....	....	....
17	3 "	12	....	....	27	2	....	10	....	....	4	250	*e*
18	3 "	30	8	3	9	....	....	....	....	....	....	....	*f*
19	3 "	......	....	....	1	....	....	....	....	1	....	....	....
20	8 "	......	....	....	....	....	....	....	....	1	....	....	....
21	8 "	174	....	1	....	....	....	....	1	....	....	....	....
22	15 "	245	....	....	4	....	....	....	....	....	....	....	*g*
23	15 "	310	....	1	1	....	....	....	....	....	....	....	....
24	18 "	132	....	....	....	....	....	....	....	....	....	....	....
25	18 "	244	....	....	....	....	....	1	....	....	1	....	....
	Total..	2 462	444	64	92	10	4	77	2	7	8	250	....

[a] A few brook trout scales.
[b] One little fresh-water mussel.
[c] Antenna of adult ♂ chironomid of small size.
[d] Carabid beetle claw.
[e] Scolytid beetle elytron and two little adult Chironomids.
[f] Achorutes sp.? (Order Thysanura).
[g] Three little adult Chironomids.

In this table the food species have been arranged in what seemed to be the order of their importance as constituents of the food of the trout at the time and place taken. The totals, counting larvae and pupae of a species together, are 2906 Chironomus, 156 Corethra, 14 trichopter larvae, 2 nymphs of Aeschna constricta, 7 nymphs of Callibaetis, 8 Atax crassipes, 250 (approximately) Daphnidae, and a few wholly unimportant things listed as miscellanies. The numerical ratio of these is 116.24 Chironomus, 6.24 Corethra, 10 Daphnidae, .56 trichopter larvae, .32 Atax, .28 Callibaetis, .08 Aeschna to each of the 25 trout. What may be the relative food value of these species is, of course, wholly undetermined. In arranging them in the foregoing table, I have taken into account only their relative size. I should be inclined to regard only the three first named in the table as of any considerable importance to the trout.

To my mind the chief value of this table is that it clearly indicates one species of economic importance to trout culture— the Chironomid of whose larvae and pupae an average of 116 specimens had been eaten by each trout. The largest number eaten by a single trout was 351, while three trout had eaten none at all. It is possibly significant, possibly only accidental, that the May fly nymphs were eaten chiefly by those trout that had found no Chironomids.

NOTES ON THE FOOD SPECIES OF THE TABLE

1 Chironomus sp.?

There can be no doubt that in Bone pond this is an exceedingly important species. Unfortunately, the day this fact became apparent, in the cursory examination of the food as taken from the stomachs, was the last day of study permitted us at the pond. What the species is, consequently remains unknown. Mr Johannsen has studied the larva and pupa systematically, and has treated them in part 3. His figures [pl. 49] should make the recognition of the species possible when other larvae shall have been obtained and bred.

Professor Forbes in his studies of Illinois fishes (the brook trout was not one of the fishes he studied), has clearly pointed out the importance of these small larvae as fish food: "Among aquatic insects, minute slender dipterous larvae, belonging mostly to Chironomus, Corethra and allied genera, are of remarkable importance, making, in fact, nearly one tenth of the food of all the fishes studied."[1] In his report[2] on the aquatic invertebrate fauna of the Yellowstone national park, almost every page testifies to the abundance, general distribution and ecological importance of Chironomus. On page 228 are given some observations indicating that it is of as great importance to young trout as to adults:

> The pond was swarming with mountain trout (Salmo mykiss), a few of which I dissected for a determination of their food. One of these an inch and a half in length had eaten Chironomus larvae and imagos chiefly, the remainder of its latest meal consisting of other insect larvae, not in condition to identify, and the entomostrachan Polyphemus pediculus. A second, an inch and a quarter long, had also fed on Chironomus in its various stages of larva, pupa and imago, but had made about a third of its meal of Entomostracha. Another, still smaller (.92 of an inch long) taken from the open lake among the small weeds growing on a flat, muddy rock, had filled itself with Chironomus pupae only, as had still another of the same size. A third specimen from this situation had eaten more larvae of Simulium than of Chironomus, and a fourth had also eaten Simulium larva and another dipterous larva unknown to me. I may add here that other young trout, in a small swift rivulet near the Lake hotel, were feeding continuously, Aug. 9, on floating winged insects, mostly, if not all, Chironomus and smaller gnatlike forms.

With these certain indications of the economic importance of the genus at hand, it is indeed time we were able to recognize its species. Mr Johannsen's work in part 3 is a beginning in that direction. All the above mentioned references, as well as most others to immature stages wherever published, are to the genus only; and Chironomus is a great genus, and includes forms with considerable diversity of structure, habitat and habits. It is quite probable that with pond culture, as with agriculture, when real progress begins it will be necessary to recognize not only species, but also varieties of the more important species.[1]

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[1] Ill. State Lab. Nat. Hist. Bul. 2, p.483.
[2] U. S. Fish Com. Bul. 11, p.207-56.

Notwithstanding the indefiniteness of our knowledge concerning Chironomus as a whole, it may be worth while to venture some general observations concerning the habits of the genus, since these will explain some peculiarities of the table. Among the larvae attributed to the genus there is considerable diversity of structure, and a very striking range of color. Color differences have led to the distinction "white larvae" and "red larvae" in such papers as the one above quoted. The distinction is arbitrary, however, and of very limited applicability. The range of color is continuous from bright crimson in some of the red larvae to translucent pale yellowish or greenish in the others. Moreover, all are "white larvae" when newly hatched; and the red color is correlated with a considerable increase in size without a corresponding development of the tracheal system in the body, and is due to the increase of hemoglobin in the blood plasma. In general, it may be said that the "red larvae" are larger, have a more extensive development of blood gills, and live in deeper or less well aerated water; the "white larvae," most of which are not Chironomus in the stricter sense, are as a rule smaller, have little development of blood gills or of hemoglobin in the blood plasma, and live in rapids, on shore vegetation in shallower, cleaner, better aerated water.

The Chironomus of the foregoing table is one of the larger species, with larvae of bright red color. Many of them were alive when taken from the trout stomachs, and wriggled about as actively as if just taken from the water. In shore collecting none were found, but a few of their loose, flocculent gelatinous cases were found at the farthest reach of a long handled net (depth 5-6 feet). The species is doubtless a denizen of the deeper water, which is the proper feeding ground of the trout. It lives on the bottom in the midst of a very thin layer of silt and vegetable debris covering the white sand. Its loose gelatinous case is covered with adherent silt, and takes on the general, protective color of the bottom. As is well known, the larvae of the larger red species are among the most characteristic bottom forms in all our larger and deeper lakes, being usually associated with deep water mollusks (Pisidium) and caddis fly larvae. This distribution, the natural abundance of the larvae, and the constant succession of generations through the year, leaving no period of absence of the larvae from the water, constitute the claim of these larvae to economic importance.

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[1] Several British species are characterized in their immature stages, and a good general introduction to the study of the biology of the genus is now available in Miall & Hammond's *The Harlequin Fly*, Oxford 1900.

The pupae at first are red, but that color is generally quickly obscured by the development of the pigment of the adult insect. Within a few days at most after the transformation from the larva, the pupa rises to the surface and floats there, descending when disturbed, but quickly rising again. Pupae are less uniformly distributed over the surface than are larvae over the bottom, for the wind may drive them together in great masses. Pupae are often taken in numbers in a surface net in towing; larvae are rarely taken so, and then only at night, and in shallow water, for the larvae often leave their retreats at night and go swimming considerable distances with figure-of-eight loopings of the body.

It will be seen in the table that, with the exception of trout 11, every trout that had eaten Chironomus at all had eaten either larvae or pupae largely in excess; a large number of one stage, few or none of the other. In the light of the differences in habits of larvae and pupae just stated, this should indicate that some of the fish had been feeding chiefly or wholly at the bottom, others at the surface of the pond. The larger number of larvae eaten may indicate either that larvae were more easily obtained, or that they were preferred, or that bottom feeding was preferred.

2 Corethra

This is another form that is common in our northern lakes generally. It was not studied at Bone pond, and was collected there only by the trout. Corethra plumicornis is common in a pond on the campus at Lake Forest, and there I have observed its habits for several years.

The larvae are free swimming and are found most abundantly beyond the line of the shore vegetation. They are entirely transparent, except for two pairs of air sacs and some pigment in the eyes, and, generally, food in the alimentary canal, appearing as a dark line through the middle of the body. Their transparency doubtless secures them some immunity from enemies. I have experimented with feeding them to a hungry nymph of a dragon fly Libellula pulchella. Placed in the nymph's mouth, they were eaten with avidity, but, placed thickly in the water with it and swimming around within easy reach, none were captured or even reached after by the nymph. It was probably unable to see them, for it quickly seized water boatmen (Corisa) when substituted for the Corethra larvae. I very much doubt whether the trout can see them. If they are as abundant in Bone pond as they often are in my campus pond, even the considerable number shown in the table, might, I think, have been taken in the straining of the water through the gill rakers, without selection of any individuals for capture.

The pupae of Corethra are at first likewise transparent and free swimming, but soon rise to the surface and float there, like Chironomus, and just before transformation, become darker colored. The imagos settle on low vegetation around the borders of the water, or rise, dancing in swarms in sheltered and sunny places. The females deposit the eggs on the surface of the water, laying them down flatwise, in a spiral held together by scanty gelatine.

Among insects these larvae are the most independent of the shore vegetation. They feed on free swimming unicellular plants and animals. In my campus pond during April and May (the months of my observation) they live chiefly on a species of Peridinium, with a sprinkling of other flagellate infusorians. Specimens taken freshly from the pond generally show a distinct brown streak through the middle of the body, due to the Peridinia eaten. They are not incapable of disposing of much larger prey, however. Very frequently in my aquariums, after the supply of other food has run out, I have found a larva, with another larva of its own species and nearly of its own size, two thirds swallowed and one third digested.

We have but few species of Corethra, and they are much alike, and should be readily recognized generically in larval and pupal stages by comparison with the figures given on plate 39.

3 Unknown trichopter larva from bottom of Bone pond

This is another species that lives outside the line of the shore vegetation. Just outside that line, on bottoms shallow enough to be reached with a long handled sieve net, Mr Betten found the cases of the species in great abundance, but they were all empty. He has described the case in bulletin 47, page 572, as no. 2.

Because all students of our lake bottoms have reported caddis fly larvae along with Chironomus larvae as a constant part of the fauna, I have thought it desirable to have the structural characters of this species illustrated as fully as possible in the hope of its recognition by comparison in the future. The only specimens seen were obtained from the trout stomachs, and were pretty well digested. Some of the cases were fairly well preserved, but the pupae were so badly disintegrated as to be hardly distinguishable as pupae; the parts of the larvae most strongly chitinized, and the parts most important for the distinguishing of the species were fairly well preserved, and have been used, together with a perfect case collected from the water and apparently belonging to the same species, as a basis for the figures presented on plate 6.

The trout swallow the animals case and all, doubtless being unable to get them apart. The case persists after the animal within has been disintegrated, but the sand grains gradually fall off, and the brown, lining tube of silk gradually breaks up into fragments. Most of the stomachs contained a little sand, doubtless derived from this source, and trout nos. 2, 3, 6, 7 and 17 contained large quantities loose, in addition to that still on the walls of the cases remaining.

4 Aeschna constricta

The nymphs of this dragon fly live in the midst of the shore vegetation in shallow water. The trout that eat them probably have to go beyond the confines of their usual feeding grounds to get them. The advanced stage of digestion in which the specimens were found seemed to indicate that the specimens had been taken during the preceding night. Aeschna nymphs attached to a hook were taken by the trout, but not more readily than minnows, small frogs or other bait.

These were the largest animals the trout had eaten. The volume of one of them would equal perhaps that of 15 to 20 Chironomous larvae, or 30 to 40 Corethra larvae, or 5 to 7 caddis fly larvae, or 4 to 5 Callibaetis nymphs. They are among the most powerful members of the aquatic insect community and clamber about frequently on exposed places on plant stems, where the trout, if at hand, might easily seize them.

In a small way the dragon fly nymphs are competitors of the trout for food. They eat small insects promiscuously, and doubtless many pupae of Chironomus and Corethra fall victims to them. They will eat young trout, also, as long as themselves. I demonstrated this at Saranac Inn by confining them together in a breeding cage. One little trout would be captured quickly, and then the others would be wary of the nymphs and keep away from them well, so that we would think they would evade a similar fate, but one by one they would disappear till all had been eaten. The Aeschna nymph approaches its prey with the slowness and poise and stealth of a cat till within striking distance. Plate 5, figure B, shows a nymph of this species poising for a stroke at a backswimmer (Notonecta).

The adult dragon fly is shown also on this plate. Transformation occurs in the latter part of June and in July. The female inserts her eggs by means of an ovipositor into the stems of plants just below the surface of the water. The eggs hatch in about three weeks, and the little nymphs at once take up their abode among the submerged plants and eat promiscuously any other animals they can overpower; they also eat one another.

I have not been able to determine as yet whether in relation to trout culture Aeschna is more disadvantageous than otherwise. It eats a few of the fry and it eats the food of the larger trout; but, on the other hand, it furnishes a moderate supply of food itself for the larger trout.

Out in the proper foraging ground of the trout, burrowing shallowly under the silt of the bottom of the pond, are other dragon fly nymphs of the genus Gomphus, which would seem to be wholly detrimental. They feed voraciously on other insects of the bottom fauna, and, doubtless, on Chironomus larvae, while by their burrowing habits they seem to escape the trout altogether.

5 **Callibaetis** sp.?

These nymphs, like the preceding, were found in an advanced stage of digestion. That they were Callibaetis, however, was determinable from the structure of the jaws, the top of the thorax and the bases of the setae, which were preserved. Since no adult May flies were collected at the pond and no nymphs bred, what the species is could not be established. Callibäetis ferrugina was taken at the hatchery, and the nymphs may very well have belonged to this species.[1]

This is a large genus, peculiar to the new world. A considerable number of species are already described, and doubtless many more will yet be discovered. I have found the nymphs exceedingly abundant in many small lakes and ponds. They are most abundant amid the shore vegetation, but wander out into deeper water, resting on the bottom, and darting rapidly from place to place. I think it likely that they will be found more important as the food of young fishes than of adults, because of their greater abundance in the shallower water.

It is due to the occurrence of a new species of Callibaetis in my campus pond at Lake Forest, where, with my students, I have watched it year by year, that I am able to give some facts respecting the genus, which have a bearing on its economic status. The nymphs are associated with Corethra larvae, and, like them, are generally in excessive abundance at all seasons of the year. Unlike the better known May flies, this species has no single period of transformation; but imagos may be found beside the pond most of the time from April till September. There are, to be sure, as with Corethra, a larger number in evidence at the beginning of their season, about the middle of May, than at any time thereafter, but that, I think, is due to the cold weather retarding the process of transformation more than it retards growth. I have found the imagos quite abundant in September. This repetition and overlapping of generations makes for continuity of food supply in the water.

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[1] While this is going through the press there comes to my table a description of the nymph of this species with figures by Berry, in the *American Naturalist*. 1903. 37:29, 30.

The nymphs at transformation climb up only to the surface on some support, and then leave their cast skins floating on the water. The subimago stage lasts about 24 hours and is spent, as is usual, inactively. The male imagos are much in evidence, flying in little flocks in sheltered places in the sunshine, weaving up and down in their peculiar, rapid, dancing flight, and scattering on the approach of a net and settling on the reeds so quickly and sitting so quietly that they usually entirely disappear from view. I have found it difficult to capture many specimens of this species, even when they are abundant. The females are very seclusive. I have rarely found one flying with the males, or been able to discover one resting on shore. They are frequently seen floating on the surface of the pond, resting on the water with wings outspread, in which manner, like many other species of May flies, they deposit their eggs.

I append a description of this species in both adult and nymphal stages. The accompanying figures will suffice for the recognition of the genus. The adults of the genus are recognizable by the costal band of brown on the wings, best marked in the female, and the generic characters of the nymphs are stated in the table for the genera of May fly nymphs given in bulletin 47 on page 419.

Callibaetis skokiana n. sp.

Plate 7

Imago. Length of body 9–10mm; expanse of wings 18–20mm; length of setae, male 20mm, female 16mm. Ground color pale flesh tint, tinged with yellow (more yellowish in the female) marked, mottled and dotted with brown; antennae, legs and setae white.

Head pale brownish, with whitish margins; in the male, occupied superiorly by the large turbinate superior portion of the compound eyes, which are pale egg-yellow on their superior, faceted surface, with paler margins, and which are as large as all the remainder of the head; in the female the top of the head is very flat, and is traversed by two longitudinal, irregular, pale brown bands, which are surrounded and separated by whitish.

Prothorax paler, thickly dotted with brownish color. Dorsum of the mesothorax with a pale, longitudinal median suture, each side of which is a band of brown rounded off posteriorly, and at the sides there are brown spots inferiorly. The median narrow pale line is continued posteriorly to the abdomen, and there are brown spots on the sides of the metanotum. Sides of thorax irregularly speckled with brown. Legs white with darker markings at the knees and at the ends of the tarsal segments, the last one of which is wholly washed with brown. Wings with the usual costal band, differing in the sexes, behind which they are hyaline. The band in the female is darker and better developed. It covers proximally the bases of all the veins and is regularly narrowed to the apex, ending just before the apex of the wing, not lobed posteriorly, fenestrate with hyaline on most of the cross veins except toward the base, and reduced to a yellowish wash in the stigmatic region and about the humeral cross vein. In the male the costal fascia is paler, and usually disappears just before the yellowish stigmatic space, which is sometimes filled with anastomosing cross veins. The venation of the male is shown in figure 1. There is much variability in the

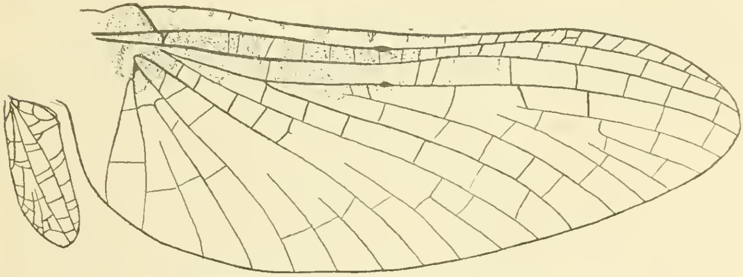

Fig. 1 Wings of Callibaetis skokiana, male

number of cross veins in any part, but in general they are more numerous in the female. Behind the costal brown band in the female there are about 70 cross veins, not in a single row, not in regular rows at all.

Abdomen pale yellowish or flesh tinted, thickly dotted and dashed with brown, tending to form a dark middorsal band, more or less completely divided on the base of each segment, a line of brown dashes each side just above the pale lateral margin on segments 1–9, with a more or less separate curved mark above the anterior end of each dash. At the sides the metathorax overlaps the first abdominal segment and almost reaches the base of segment 2. The ventral side of the abdomen is paler with more uniform dots and a pair of submedian brown ( )– marks on segments 2–9, abbreviated on segment 9. Forceps of the male [figure 2] and setae of both sexes pure white.

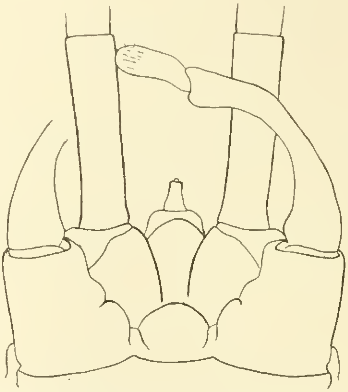

Fig. 2 End of abdomen of Callibaetis skokiana, male, ventral view, showing forceps, rudimentary median caudal filament and bases of lateral filaments

Subimago. Differs in having the setae shorter (about 9mm long in both sexes), the wings faintly smoky brown, or slightly tinged with yellowish on the middle of what is to be the costal band, and the principal bands of brown on the body faintly indicated.

Nymph. Length of body 12–13mm, setae 6–7mm additional; width of head 1.2mm, of thorax 1.8mm. Color greenish, marked with pale fuscous.

Head pale, suffused with brownish around the eyes and across the ocelli in front, a longitudinal band bounding each eye internally, tinged with yellowish.

Prothorax pale marked with fuscous on the front margin and at the sides, with a pair of pale spots in irregularly contoured brown inclosures on the dorsum. Mesothorax and metathorax darker dorsally with pale markings at the front margin and at the rear between the wings; brown spots on the base and in the furrows of the wings. Legs pale, smooth, somewhat infuscated on the tarsi.

Abdomen with a median dorsal interrupted band of brown, preceded by an urceolate divided brown mark on the metathoracic dorsum, furcate anteriorly on segment 1 of abdomen, broadly overspreading segments 2 and 3 with additional brown spots at the sides and divided by paler apically; reduced to a slender T-mark on 4, the T-mark and lateral spots reappearing on 5, the T-mark joined to an apical transverse line on 6, and on 7, fused with the lateral spots, a median line with lateral ()–marks on 8 and 9, 10 with the line and the margins narrowly (the apical margin more broadly) fuscous.

Gills on segments 1–7, on 7 simple, and almost symmetric, a slightly indicated basal lobe on the posterior side, on 6, 5, 4 and 3 this basal lobe is successively more pronounced, becoming separated by a deep notch on 3; on 2 and 1 this lobe becomes a third as large as the body of the gill under which it is then folded, and a shallow incision appears on the anterior side of the body of the gill, nearer apex than base. All gills erect, with tracheae pinnately branched. The setae are pale with a wash of darker color near the tip.

Other items in the food

The eight water mites, Atax crassipes Müll., found in the food may well have been taken accidentally, as they are so small they could scarcely have been taken otherwise.

The large number of Daphnidae found in a single stomach is a peculiarity for which I have no explanation to suggest. They were in an advanced state of digestion, and the number given is only approximate. There were fragments of what I took to be Daphniae in the stomach of trout 5 also, but scarcely recognizable. The difficulty of recognizing and counting these was quite in contrast to the ease and certainty with which the same things were done for the other food constituents. The heads of Chironomus and Corethra were most distinctive, and were the parts longest resisting digestion, so that among a mass of fragments it was only necessary to count the heads.

The items listed as miscellanies were doubtless all accidental and unimportant. I think that the trout scales found did not indicate that any trout had been eaten, but only that they had been fighting, and this one had bitten another deeply enough to loosen a bit of its cuticle.

Part 3

LIFE HISTORIES OF ODONATA

SUBORDER ZYGOPTERA

Damsel flies

BY JAMES G. NEEDHAM

The discussion of this suborder here is to be regarded as a continuation of the study of the order from Museum bulletin 47, wherein the suborder Anisoptera was treated, and 62 life histories were detailed. Only the fauna of the State is discussed, and the bibliographic notes have here the same limited scope and purpose. No descriptions of imagos are given, but the reader is referred to well known descriptive catalogues, and it is hoped that the keys to imagos given herewith, together with the figures, may prove sufficient for the determination of our species. My purpose has been to make known the immature stages, and to that end, nymphs of all the species whose life histories are known are newly described.

In the suborder Zygoptera 38 species have been listed from New York State hitherto: 36 by Calvert[1] and two additional by Davis.[2] To this number we are able to add four species: Lestes vigilax from Cold Spring Harbor L. I.; Enallagma piscinarium and E. pollutum from Ithaca and Nehallennia gracilis from Saranac Inn. Of the 42 species thus known from the State, we have reared 23, and describe herewith, in more or less detail, their nymphs. All these descriptions are new, and apparently the first that have been written for our species though Hagen[3] has briefly stated the group characters of our genera of Calopterygidae. Of these 23, three are Calopterygidae, five are Lestinae and the remaining 15 are Agrioninae: and, fortunately, the nymphs of all our genera are now known.

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[1] Thirty-five in his Odonata of New York State. N. Y. Ent. Soc. Jour. 3:39-48 and 5:91-96 and one in Ent. News. 12:326.

[2] Preliminary List of the Dragon Flies of Staten Island. N. Y. Ent. Soc. Jour. 6:195-98.

[3] Essai d'un Synopsis des Larves des Calopterygines. C. R. Ent. Soc. Belg. 1880. 23:65-67.

In view of the fact that the nymphs of about half our species, including some of the commonest, are still unknown, a word to the collector, additional to what has been said in Bulletin 47, will be in order here. The Zygoptera are very easily reared. Nymphs taken when grown will transform readily in any sort of aquarium containing plant stems for them to climb on. Males should be bred for certain determination; and the male imago when well colored should be placed at once with its cast skin in a vial of 70% alcohol and promptly labeled.

But, unlike most Anisoptera, the Zygoptera transform commonly in the daytime; and it thus becomes a very easy matter at the right time to pick up life history material. At the time when any species known to be locally common is just beginning to appear on the wing, one may go to its aquatic haunts, expecting to find with a little searching nymphs on stems near the surface of the water, others crawling out or transforming, imagos beside their recently abandoned nymph skins and teneral imagos taking flight. At this time it will not do to assume that all that look alike are the same species. Owing to the exceedingly close likeness of many of the species in such genera as Lestes, Argia and Enallagma, one must select males for certain determination, must keep each imago with its own cast nymphal skin, and must keep the imago alive till the form of the appendages and the color pattern are fully developed. This last point is readily secured by placing the imago and skin when newly transformed in a paper bag for 24 hours, closing the top and avoiding undue jostling about at first.

KEY TO FAMILIES AND SUBFAMILIES OF ZYGOPTERA

Imagos

a Quadrangle [*see* fig.8] of the wings divided by a number of cross veins; antenodal cross veins numerous; pterostigma lacking a special brace vein; wings rather broad...............Calopterygidae

aa Quadrangle without cross veins; antenodal cross veins but two in each wing; pterostigma with a brace vein at its proximal end in the space behind vein R_1; wings narrower.............. Agrionidae

b Vein M_3 arising (i. e. separating from vein M_{1+2}) nearer the arculus than the nodus...... Lestinae
bb Vein M_3 arising nearer the nodus than the arculus .... Agrioninae

Nymphs

a Basal segment of the antenna very large, as long as the other six together; median lobe of the labium with a very deep cleft; gills thick, the lateral ones triquetral........................Calopterygidae
aa Basal segment of antenna not longer than succeeding single segments; labium with a very shallow closed median cleft or no cleft at all; gills thin, lamelliform........................ Agrionidae
b Median lobe of labium with a short, closed, median cleft; lateral lobe trifid at end; movable hook bearing raptorial setae; gills showing transverse segmentation............ Lestinae
bb Median lobe of labium entire; lateral lobe bifid at end; hook naked; gills various....... Agrioninae

Family CALOPTERYGIDAE

This family includes in our fauna but two genera, Calopteryx and Hetaerina, both of which frequent strong flowing, permanent streams. The long legged, protectively colored, rather stiff and awkward nymphs cling to submerged vegetation, generally where it is washed by the current of the stream.

KEY TO GENERA

Imagos

a Basal space (space before the arculus) in all wings free from cross veins..................................Calopteryx
aa Basal space of all wings traversed by cross veins..... Hetaerina

Nymphs

a Median cleft of the labium extending far below the level of the base of the lateral lobes; abdomen without lateral spines; dorsum of prothorax rounded at the sides ....Calopteryx
aa Cleft of the medium lobe of the labium extending only to the level of the base of the lateral lobes; lateral margins of abdominal segments 7-9 generally ending in small, flattened lateral spines; dorsum of the prothorax with two angulate teeth each side........... Hetaerina

CALOPTERYX

This strongly marked genus is abundantly represented about the borders of creeks and small rivers throughout the State, specially where such streams traverse rocky woods. The showy imagos, with their black or smoky wings, and bodies of brilliant metallic green, are very conspicuous, and well known insects. They usually remain in proximity to their native streams, but sometimes follow paths for a considerable distance through adjacent woods. Their flight is poor and fluttering, and on windy or cloudy days they keep rather closely to shelter. The nymphs rest on silt-covered vegetation or on roots swaying in the current, and are rather inactive, moving but little from place to place.

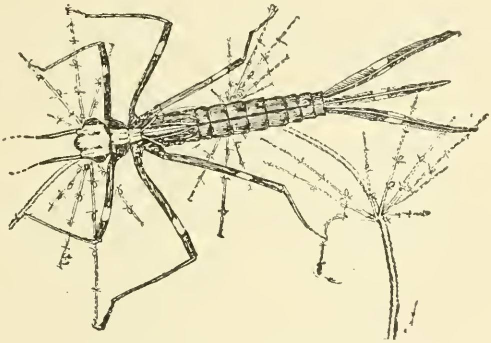

Fig. 3 Nymph of Calopteryx maculata

The known nymphs agree in the possession of long cylindric bodies, heads dorsally depressed, antennae with unusually developed basal segment, exceeding in length all the other segments put together, labium with a median cleft which divides the median lobe far below the level of the bases of the lateral lobes, a pair of spinules beside the cleft within, and three others at the base of each lateral lobe, legs long and thin, radiately arranged, gills three, variable in proportions, but always stout, the lateral pair with external carina, the middle one two-edged, all easily broken off, and generally wanting from specimens that have received too rough treatment.

KEY TO SPECIES

Imagos

a Wings narrow; hind margin straight for a distance, and parallel to front margin
  b Wings uniformly colored or transparent
    c Wings clear.................................angustipennis
    cc Wings yellowish.............................amata
  bb Apical sixth of wings black......................apicalis
aa Wings dilated, with hind margin visibly rounded
  b Apical third of the hind wings blackish........aequabilis
  bb Wings uniformly blackish or smoky...........maculata

Nymphs

a Basal segment of the antenna one third longer than the head is wide.......................aequabilis
aa Basal segment of the antenna hardly longer than the head is wide..........................maculata
aaa Unknown ....angustipennis, amata, apicalis

Calopteryx angustipennis Selys

1853 Sylphis angustipennis Selys, Acad. Belg. Bul. 20:9
1854 Sylphis elegans Hagen, Monogr. Calopterygines, p.23, ♀.
1861 Calopteryx angustipennis Hagen, Synopsis Neur. N. Am. p.56
1875 Calopteryx angustipennis Hagen, Bost. Soc. Nat. Hist. Proc. 18:20 (full bibliography and notes)
1889 Calopteryx angustipennis Hagen, Psyche, 5:242 (description)
1900 Calopteryx angustipennis Williamson, Dragon Flies Ind. p.253 (description and account of habits)

This elegant, clear winged species has not been found as yet within the State, but Mr Williamson has found it locally abundant in western Pennsylvania. Its nymph is unknown.

Calopteryx amata Hagen

1889 Calopteryx amata Hagen, Psyche, 5:242 (original description)
1895 Calopteryx amata Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Keene Valley: descriptive notes)

To the above record of a single capture of this species at Keene Valley, I have only to add the record of another capture on the other side of the Adirondacks, at Axton in June 1901, by Mr A. D. MacGillivray. The nymph is unknown.

Calopteryx apicalis Burmeister

1839 Calopteryx apicalis Burmeister, Handb. Ent. 2:826 (original description)
1861 Calopteryx apicalis Hagen, Synopsis Neur. N. Am. p.56 (description)
1875 Calopteryx apicalis Hagen, Bost. Soc. Nat. Hist. Proc. 18:21 (bibliography and distribution)
1889 Calopteryx apicalis Hagen, Psyche, 5:246 (a full description)
1893 Calopteryx dimidiata, race apicalis Calvert, Am. Ent. Soc. Trans. 20:228
1895 Calopteryx dimidiata, race apicalis Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Westchester county)
1900 Calopteryx dimidiata, race apicalis Williamson, Dragon Flies Ind. p.253 (description)

This southward ranging species seems likely to be met with only at the lower altitudes in the southern parts of the State. Its nymph is unknown.

Calopteryx aequabilis Say

1839 Calopteryx aequabilis Say, Acad. Nat. Sci. Phila. Jour. 8:23
1861 Calopteryx aequabilis Hagen, Synopsis Neur. N. Am. p.58
1875 Calopteryx aequabilis Hagen, Bost. Soc. Nat. Hist. Proc. 18:21 (bibliography and distribution)
1889 Calopteryx aequabilis Hagen, Psyche, 5:246 (full description)
1899 Calopteryx aequabilis Kellicott, Odon. Ohio, p.9 (description)
1900 Calopteryx aequabilis Williamson, Dragon Flies Ind. p.252 (description)
1895 Calopteryx aequabilis Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Keeseville)

This species is common near Axton along Stony brook and Raquette river. At Saranac Inn, 15 miles farther north, but two or three specimens were taken during the entire season. On July 31, 1900 Mr Betten and Mr Swett made a special trip down to Axton to get its nymph. All the specimens they brought back to Saranac Inn were kept there till the close of the season of our work, but failed to transform. They showed however a greater length of basal segment of antennae than the nymphs of C. maculata found at Saranac Inn, and have therefore been referred by supposition to C. aequabilis. By way of description I will give the measurements of one of the largest nymphs, (length 23mm, antennae 5mm and gills 13.5mm additional) and add that the nymph seems entirely like that of C. maculata except in its more uniform coloration and in the diagnostic character already stated in the key.

Calopteryx maculata Beauvois

The blackwing

Plate 11

1805 Agrion maculata Beauvois, Ins. Afr. Am. p.85, Neur. pl.7, fig.3

1861 Calopteryx maculata Hagen, Synopsis Neur. N. Am. p.57

1875 Calopteryx maculata Hagen, Bost. Soc. Nat. Hist. Proc. 18:22

1889 Calopteryx maculata Hagen, Psyche, 5:246 (full description)

1893 Calopteryx maculata Calvert, Am. Ent. Soc. Trans. 20:227 (description)

1895-97 Calopteryx maculata Calvert, N. Y. Ent. Soc. Jour. 3:41 and 5:92 (listed from many localities in the State)

1899 Calopteryx maculata Kellicott, Odon. Ohio, p.8 (description)

1900 Calopteryx maculata Williamson, Dragon Flies Ind. p.251 (description)

This is our common species. In early summer it may be observed poising on some green twig beside any clear stream, or lending animation to the scene by the show of its brilliant colors in flight. At this season the cast skins may be looked for along any bank near which the imagos are flying, sticking fast to some support in a sprawling attitude close to the surface of the water.

Nymph [fig.3]. Length 20mm, antennae 4mm and gills 11mm additional, 35mm in all.

Elongate, slender, smooth; greenish brown, with a broad band of paler color nearly covering the flat upper surface of the head, and tapering backward on the thorax; paler rings on the middle of femora and gills; obsolete band of darker brown on the sides of the body, best defined on the sides of the thorax and rear of the head; a middorsal line of brown on the abdomen, interrupted at the sutures; gills usually paler at extreme tip.

Labium [pl.14, fig.*a*] elongate, reaching posteriorly between the bases of the middle legs; no raptorial setae, but a spinule each side of the deep median cleft within, and three others at the base of each lateral lobe. Movable hook strong, arcuate. Distal end of lateral lobe divided.

Legs long, slender, smooth; no lateral carinae or spines on the abdomen; wings reaching the middle of the fourth segment; gills thick, with smooth and not very sharp carinae.

In half grown specimens femora, tibiae and gills are often distinctly triple banded with brown, and the median cleft of the labium extends hardly below the level of the bases of the lateral lobes.

The females descend on stems of more or less completely submerged aquatic plants (such as Elodea), and, unattended by the males, insert their eggs thickly into the green stems, just below the surface of the water.

HETAERINA

This genus includes some of the most beautiful of insects. It is abundantly represented in the tropical parts of America; but for our State a single species is recorded. Another species which occurs in Pennsylvania may yet be discovered within our borders.

The common northern species, H. americana [pl.12], frequents slow flowing streams. The imagos are on the wing in late summer and early autumn, flitting about the borders of riffles. The males are very showy, and are easily distinguished from all our other dragon flies by the presence of a bright crimson streak on the base of each wing. Though their flight seems rather fluttering and uncertain, they are not very easy to capture when at the hight of their activity: they dodge quickly, and fly across stream frequently. Once, while collecting with a net of red mosquito bar, after trying vainly for half an hour to capture a specimen where specimens were not scarce, I stopped in discouragement with the net under my arm, the bag behind me, and rested. A moment later, looking back over my shoulder, I saw a fine male Hetaerina sitting on the edge of my net. Carefully disengaging the handle from my arm, I managed to sweep him into the bag. Then I turned my attention to the others that were fluttering about the stream, and found I could easily accomplish by strategy what I had failed to do by force. There were few good alighting places about the stream, and I found that, if I held the net motionless in front of a flying male he would promptly alight on the edge of it.

But specimens may be captured directly with little trouble at morning or evening, or on cloudy days, when they are less active. Sometimes they assemble in large numbers on the pendant boughs of a willow bush beside a stream at evening, forming with their crimson streaked wings and bodies of black and bronze against the willow background, so charming a picture that the collector will hesitate to disturb it.

The nymphs cling to plants in the rapids; occasionally they live on bulrush stems that fringe the wave-washed shore of a lake. Transformation takes place just above the edge of the water, and, with us, in the month of August. Our common species I have bred several times in widely separated localities. It does not occur at Saranac Inn. It has been several times taken at the head of Cayuga lake at Ithaca. This species (H. americana) may be separated from H. tricolor as follows:

KEY TO SPECIES

a Tibiae with the exterior side yellow..................americana
aa Tibiae entirely black.................................tricolor

Hetaerina americana Fabricius

Plate 12

1798 Agrion americana Fabricius, Ent. Syst. Suppl. p.287
1839 Lestes basalis Say, Acad. Nat. Sci. Phila. Jour. 8:35
1839 Calopteryx americana Burmeister, Handb. Ent. 2:826
1854 Hetaerina americana Selys, Monogr. Calopteryginae, p. 131, pl.12, fig.3.
1861 Hetaerina americana Hagen, Synopsis Neur. N. Am. p.60
1863 Hetaerina americana Walsh, Ent. Soc. Phila. Proc. 2:211, 267
1875 Hetaerina americana Hagen, Bost. Soc. Nat. Hist. Proc. 18:23
1893 Hetaerina americana Calvert, Am. Ent. Soc. Trans. 20:228
1895-97 Hetaerina americana Calvert, N. Y. Ent. Soc. Jour. 3:42 and 5:92 (listed from Keeseville, Ithaca and Albany county)
1895 Hetaerina americana Kellicott, Cincinnati Soc. Nat. Hist. Jour. (habits)
1899 Hetaerina americana Kellicott, Odon. Ohio, p.4
1900 Hetaerina americana Williamson, Dragon Flies Ind. p.254
1901 Hetaerina americana Howard, Insect Book, pl.46, fig.11
1901 Hetaerina americana Calvert, Biol. Centr. Am. vol. Neur. p.26-29, pl.2, fig.1–17 (a most complete account of imago)

This is the common and perhaps the only species in New York State. The above account of the habits of the genus has been written with this species in mind. It is as yet recorded from but three localities in the State, but it will doubtless be found in many other places when proper search is made for it. Its nymph has not been described, but in 1880 Dr Hagen drew characters distinctive of the genus from nymphs which he referred to H. californica, H. americana, H. titia and an undetermined species from Brazil,[1] and Calvert[2] and Williamson[3] have used these characters in keys to American nymphs.

Nymph. Length of body 17mm; antennae 4mm additional; gills 7mm additional. Color greenish or brownish, paler on the sutures, on legs and on margins of gill plates, but without distinct color pattern. Occasional specimens show faint indications of darker transverse bands on the tibiae and gill plates.

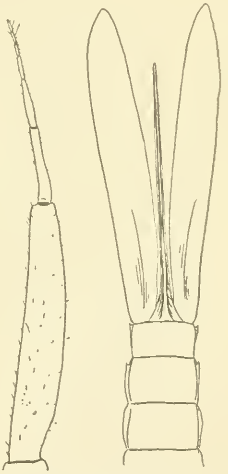

Fig. 4 Antenna, and end of abdomen showing lateral spines and gill plates, of nymph of Hetaerina americana

Head flat above, with rounded eyes set well forward, with hind angles obtuse and having a much less distinct superior tooth than that of Calopteryx. Antennae long, inserted into large frontal prominences, somewhat shorter than the head is wide, the first segment longer than the following six, which rapidly and successively decrease in length and thickness. Labium long, the hinge extending posteriorly between the bases of the middle legs; mentum suddenly and greatly dilated in its apical half, its median lobe divided into two lobes by a median cleft, which is rounded basally and extends barely below the level of the bases of the lateral lobes of the labium; the distal end of the cleft is closed by the apposition of the two divisions of the median lobe; beside the cleft on either side is a single small spinule. Each lateral lobe of the labium is straight on its outer margin, with a moderately strong and arcuate movable hook, just before the base of which on the superior margin are three small spinules. The exposed portion of the inner margin is strongly convex, and finely serrulate, and terminates after a sigmoid curve, in a short, stout, strongly arcuate end hook;

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[1] Ent. Soc. Belgique, Compte Rendu, 23:65.

[2] Am. Ent. Soc. Trans. 20:225.

[3] Dragon Flies of Indiana, p.247.

above the end hook on the distal margin are two other strong hooks, the one next the end hook being twice the size of the other above it.

Prothorax with a pair of elevated, round tipped prominences each side of the dorsum. Legs thin, smooth, long. Wing cases reaching as far as the base of segment 5 of the abdomen.

Abdomen smooth, cylindric, with lateral margins becoming sharp posteriorly and generally ending on segments 7-9 in a sharp, flat, lateral spine. Gills variable in size, and easily broken off; the median one flat, the two lateral ones triquetral, all with thin margins, and apexes rather obtuse.

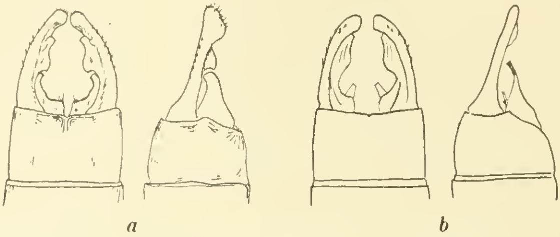

Fig. 5 Hetaerina: male abdominal appendages; *a*, H. americana; *b*, H. tricolor

Hetaerina tricolor Burmeister

1839 Calopteryx tricolor Burmeister, Handb. Ent. 2:827
1854 Hetaerina tricolor Selys, Monogr. Calopteryginae, p.136, pl.12, fig.5
1861 Hetaerina tricolor Hagen, Synopsis Neur. N. Am. p.61
1875 Hetaerina tricolor Hagen, Bost. Soc. Nat. Hist. Proc. 18:24
1893 Hetaerina tricolor Calvert, Am. Ent. Soc. Trans. 20:229
1899 Hetaerina tricolor Kellicott, Odon. Ohio, p.13
1900 Hetaerina tricolor Williamson, Dragon Flies Ind. p.255
1901 Hetaerina tricolor Howard, Insect Book, pl.46, fig.19

This handsome dark colored species is not as yet known from New York. Its nymph is unknown.

Subfamily LESTINAE

A single genus is included within our fauna.

LESTES

This large and cosmopolitan genus is represented among us by a number of interesting and beautiful species. They are abundant in marshes, in shallow pools filled with standing aquatics and about the reedy borders of streams and ponds. They are rarely seen either over open water, or at any considerable distance from water. They habitually rest among the stems of tall growing rushes and sedges, or flit from stem to stem in short, shadowy flights. Notwithstanding the brilliant metallic colors of some species, they are by no means conspicuous in their native haunts; their greens and browns, and their slender bodies and transparent wings are lost against a background of reeds and sedges.

They feed extensively, perhaps chiefly, on such small gnats, mosquitos etc. as emerge from the water of their own native shallows, or such as rest in hiding during the daytime among the rushes. I have often seen a Lestes dart out and capture a gnat in flight, and then settle on a stem to devour it at leisure.

The females (of two species at least, L. uncata and L. unguiculata) deposit their eggs in punctures made in the stems and leaves of plants above the water. For this purpose they utilize the leaves of bur reed or of any of the coarser sedges or grasses, or the flowering stems of the blue flag. The stems and leaves selected for oviposition, usually well exposed clumps here and there about the pools, are often filled full of eggs for a distance of a foot above the surface of the water.

I have studied Lestes chiefly in the two species named above, which are common about my home in Lake Forest, occurring in shallow pools of the springtime, that dry out thoroughly every summer, and are usually refilled by the rains of late autumn. I have already published[1] some observations made there, on the destruction of the fruit of the blue flag by the puncturing of the fruit stalks by Lestes ovipositing. I will give here some additional observations of facts more immediately concerning the insects themselves.

In these pools, which are always dried out by midsummer, the eggs, deposited well above the water, develop normally from the first, and in the course of two or three weeks attain a condition which is apparently almost that in which they will hatch. Then they estivate through the remainder of the summer and early autumn. Development stops apparently entirely, and remains stopped till the pools are refilled in late autumn, and the stems and leaves, now dead, fall into the water. I have gathered the eggs in the middle of July and again in the middle of October and found them at apparently the same stage of development. Eggs placed at the latter date in a bowl of water in my laboratory hatched within a week. I did not try hatching any of them earlier.

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[1] American Naturalist, 34:374-75.

Exposed as they are above the water, these eggs are subject to parasites, which destroy often a large proportion of them. From a handful of bur reed leaves well studded with Lestes eggs, I once bred large numbers of the following parasites, the two last named being hyperparasites on the third named in the list.

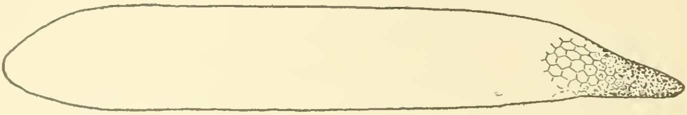

Fig. 6 The egg of Lestes uncata

Brachista pallida Ashm.
Centrobia odonatae Ashm.
Polynema needhami Ashm.
    Tetrastichus polynemae Ashm.
    Hyperteles polynemae Ashm.

The nymphs live among submerged plant stems. Their extremely slender legs, long swaying bodies, and leaflike gill plates, together with a sober color pattern of greens and browns, render them very inconspicuous when in their native haunts. In aquariums they are rather shy, and do not feed under observation so readily as do many other genera. I have observed them eating some of the larger entomostraca and smaller dipterous larvae (Corethra and Chironomus).

Since the nine species occurring in or regional in New York State have all been described several times in recent and available papers, and since the females are well nigh indistinguishable, and determinations must at present be based on the males and chiefly on the form of the terminal abdominal appendages of the males, I have not thought it worth while to give descriptions of imagos. I present a key based chiefly on the form of the male appendages, which will be sufficient, I trust, for the determination of species. Of these nine species I have reared five. I regret to acknowledge, after prolonged study of them, that I find them well nigh indistinguishable specifically. Aside from slight and inconstant differences in size and a few very minor structural characters, they are all alike. I will give therefore a general description of them and supplement it with a tabular statement of such differences as I have thus far been able to discover between them.

Nymph. The nymph of Lestes is exceedingly long and slender, with wide head, deep thorax and slender, cylindric abdomen, bearing linear-oblong gill plates. Head twice as wide as long, only moderately prominent at the front; eyes prominent, rounded, directed somewhat anteriorly; hind angles low, well rounded, with a shallow wide notch between them on the hind margin; antennae longer than the head, with the segments increasing in length to the third, and decreasing thereafter to the tip, seven-jointed. Labium [pl.14, fig.*c*] long and exceedingly slender, the hinge reaching as far posteriorly as the hind legs, but dependent, and not closely applied to the ventral surface of the body; mentum linear to the suddenly dilated, and spoon-shaped tip; median lobe moderately prominent, with a closed median cleft which extends as far proximally as the level of the bases of the lateral lobes; mental setae well developed; lateral lobe very complicated [*see* pl.14, fig.*d*], bent almost at a right angle just beyond its base, having a very large movable hook, beyond the base of which the distal portion is cleft into two parts, the inner one of which bears the end hook and the usual inner series of teeth, these being very numerous, regular and deeply cut; the outer part is widened distally, with its distal angles pro-

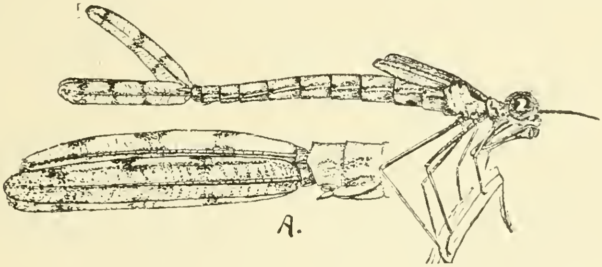

Fig. 7 Nymph of Lestes rectangularis; *A*, gills, more enlarged

duced in long hooks, of which the outer is twice the larger and each of these hooks is separated by a shallow notch from a row of 5–9 minute teeth on the distal margin. There are three lateral setae, *two on the movable hook*, and one just before its base.

Prothorax conic, tapering forward to its attachment to the head. Legs very long and slender, generally faintly annulate with darker color. Wing cases narrow, elevated, their tips hardly reaching the base of the fourth abdominal segment.

Abdomen cylindric, with lateral margins becoming sharp posteriorly, ending on the fourth or fifth to ninth segments in minute but sharp lateral spines; segments 2–9 of about equal length, 1 and 10 shorter and about equal each to the other. Gills long, with parallel sides and abruptly rounded ends, distinctly segmented for part of their length, and generally transversely banded with brown.

KEY TO SPECIES

Imagos[1]

a Inferior appendages of the male not longer than half the superiors
  b A large metallic green species: length of hind wing 25-29 mm........................ eurina
  bb A smaller, blackish brown species: length of hind wing 18-22mm..................... congener
aa Inferior appendages of the male abdomen longer than half but not longer than the superiors
  c Inferior appendages, viewed from above, exhibiting a sigmoid curvature.............. unguiculata
  cc Inferior appendages viewed from above, straight or nearly so
    d Metallic green species (when mature)
      e Inferior appendages of the male viewed from above strongly dilated toward the apex .... uncata
      ee Inferior appendages of the male very slender and straight in their apical half..... vigilax
    dd Blackish brown species
      f Apex of inferior appendages of male bent downward at the tip..................rectangularis
      ff Apex of inferior appendages not distinctly declined
        g Inferior appendages of the male viewed from above slightly widened at the tip; of the two teeth on the inner edge of superior appendage, the basal one is much the larger....................... forcipata

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[1] After Calvert. Am. Ent. Soc. Trans. 1893. 20:229-32.

gg Inferior appendage of the male not widened at tip; the proximal tooth on inner margin of each superior appendage little larger than the distal one.............. disjuncta

aaa Inferior appendages of the male longer than the superior, and bent inward and tufted with hairs at the tip.................... inequalis

Here are the differences observed to exist between the nymphs of the species I have reared.

Nymphs

a On each side of the mentum five to six raptorial setae [pl.14, fig.*c*]........forcipata and rectangularis

aa On each side of the mentum normally seven raptorial setae

b Length when full grown about 31mm............unguiculata and uncata

bb Total length when grown about 37mm....................eurina

aaa Unknown................congener, disjuncta, vigilax and inequalis

Lestes eurina Say

1839 Lestes eurina Say, Acad. Nat. Sci. Phila. Jour. 8:36

1861 Lestes eurina Hagen, Synopsis Neur. N. Am. p.70

1891 Lestes eurina Scudder, Psyche, 6:66

1893 Lestes eurina Calvert. Am. Ent. Soc. Trans. 20:229, pl.3, fig.14

1895 Lestes eurina Calvert. N. Y. Ent. Soc. Jour. 3:42 (listed from Dobbs Ferry)

1900 Lestes eurina Williamson, Dragon Flies Ind. p.256

1901 Lestes eurina Davis, Nat. Sci. Ass'n Staten Island. Proc. v.8, no.3 (not seen by me)

1901 Lestes eurina Needham, N. Y. State Mus. Bul. 47, p.518 (mention of its habitat and associates)

This large and handsome species was common at Saranac Inn about the edges of all sphagnum-bordered ponds, where it was associated with L. uncata and L. unguiculata, and with other genera. I bred it there on June 20, 1900, and again at Lake Forest Ill., where it is rather uncommon, on June 12, 1901.

Lestes congener Hagen

1861 Lestes congener Hagen, Synopsis Neur. N. Am. p.67

1893 Lestes congener Calvert. Am. Ent. Soc. Trans. 20:229, pl.3, fig.15

1895 Lestes congener Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Lake St Regis)

1895 Lestes congener Kellicott, Cincinnati Soc. Nat. Hist. Jour. 17:200, 202

1899 Lestes congener Kellicott, Odon. Ohio, p.15, fig.17

1900 Lestes congener Williamson, Dragon Flies Ind. p.256

For this species I can only add a new locality to the records of its occurrence; I have taken it at Ithaca. Its nymph is unknown.

Lestes unguiculata Hagen

1861 Lestes unguiculata Hagen, Synopsis Neur. N. Am. p.70
1893 Lestes unguiculata Calvert. Am. Ent. Soc. Trans. 20:230, pl.3, fig.16
1895 Lestes unguiculata Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Westchester county)
1899 Lestes unguiculata Kellicott, Odon. Ohio, p.16, fig.23
1900 Lestes unguiculata Williamson, Dragon Flies Ind. p.257, pl.7, fig.1

This widely distributed species I have collected at two unrecorded localities in New York State, Saranac Inn and Ithaca. I have bred it several times in June at my home in Lake Forest Ill., where it is abundant. The metallic green of the mature males is very brilliant.

Lestes uncata Kirby

1861 Lestes forcipata Hagen, Synopsis Neur. N. Am. p.71
1900 Lestes uncata Kirby, Cat. Neur. Odon. p.160 (renamed)
1893 Lestes uncata Calvert, Am. Ent. Soc. Trans. 20:230, pl.3, fig.18
1895 Lestes uncata Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Keeseville and Ithaca). 5:92 (listed from Buffalo)
1899 Lestes uncata Kellicott, Odon. Ohio, p.17, fig.20
1900 Lestes uncata Williamson, Dragon Flies Ind. p.257, pl.7, fig.2

This species flies through most of the summer at Saranac Inn, and is a common midsummer species at Ithaca. It is a characteristic denizen of shallow woodland pools. In such a pool near Glen Ellyn Ill., I once saw dozens of nymphs in transformation at a time on May 30, and I have bred the species in many places. Notes on the oviposition of this species and the last have already been given under the account of the genus.

Lestes disjuncta Selys

1862 Lestes disjuncta Selys, Acad. Belg. Bul. (2) 13:302
1893 Lestes disjuncta Calvert. Am. Ent. Soc. Trans. 20:231, pl.3, fig.19
1895 Lestes disjuncta Calvert, N. Y. Ent. Soc. Jour. 3:42 (listed from Lake St Regis, Keeseville and Ithaca)
1899 Lestes disjuncta Kellicott, Odon. Ohio, p.18
1900 Lestes disjuncta Williamson, Dragon Flies Ind. p.258.

I have not seen this species at large. Its nymph is unknown.

Lestes forcipata Rambur

1842 Lestes forcipata Rambur, Ins. Neur. p.246
1861 Lestes hamata Hagen, Synopsis Neur. N. Am. p.70
1893 Lestes forcipata Calvert, Am. Ent. Soc. Trans. 20:231, pl.3, fig.20
1895–97 Lestes forcipata Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from N. Y. city, Ithaca and Schoharie)
1899 Lestes forcipata Kellicott, Odon. Ohio, p.19, fig.19
1900 Lestes forcipata Williamson, Dragon Flies Ind. p.258, pl.7, fig.3

This widespread species I bred in June 1896 at Galesburg Ill. and in June 1898 at Ithaca N. Y. It was not observed at Saranac Inn. I have always found the species about the borders of ponds of permanent nature.

Lestes rectangularis Say

1839 Lestes rectangularis Say, Acad. Nat. Sci. Phila. Jour. 8:34
1893 Lestes rectangularis Calvert, Am. Ent. Soc. Trans. 20:231, pl.3, fig.21
1895–97 Lestes rectangularis Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Dobbs Ferry, N. Y. city, Ithaca, Saratoga lake, New Baltimore, Schoharie and Buffalo)
1898 Lestes rectangularis Kellicott, Odon. Ohio, p.20, fig.18
1898 Lestes rectangularis Needham, Outdoor Studies, p.62, 68, fig.63, 73 (account of habits and figures of imago and nymph)
1900 Lestes rectangularis Williamson, Dragon Flies Ind. p.259, pl.7, fig.5

This exceedingly attenuated species is quite similar in appearance and habits to the preceding, and its nymph, which I have several times bred, appears to me quite indistinguishable from that species. I did not find it at Saranac Inn.

Lestes vigilax Selys

1862 Lestes vigilax Selys, Acad. Belg. Bul. (2) 13:306
1893 Lestes vigilax Calvert, Am. Ent. Soc. Trans. 20:232, pl.3, fig.17
1898 Lestes vigilax Kellicott, Odon. Ohio, p.20, fig.18
1900 Lestes vigilax Williamson, Dragon Flies Ind. p.259, pl.7, fig.4

This species has not been recorded from the State hitherto. It is found at Cold Spring Harbor, L. I. Its nymph is unknown.

Lestes inequalis Walsh

1862 Lestes inequalis Walsh, Acad. Nat. Sci. Phila. Proc. p.385
1893 Lestes inequalis Calvert, Am. Ent. Soc. Trans. 20:232, pl.3, fig.24

1898 Lestes inequalis Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1898 Lestes inequalis Kellicott, Odon. Ohio, p.21, fig.22
1900 Lestes inequalis Williamson, Dragon Flies Ind. p.260, pl.7, fig.6

This species is as yet known only from Staten Island, but is very likely to be found elsewhere. Its nymph is unknown.

Subfamily AGRIONINAE

KEY TO GENERA

Imagos

a Spines on the tibiae very long, twice as long as the intervals between them............. Argia

aa Spines of the tibiae hardly longer than the intervals between them

b No pale postocular spots on the top of the head; sexes similarly colored

c Colors of dorsum blue and black; yellow beneath the thorax..................... Chromagrion

cc Colors of dorsum red and black; stout species Amphiagrion

ccc Dorsum bronzy green; slender species........ Nehalennia

bb With round or ovoid postocular spots on the head

d Sexes with a general similarity in color, the female often of a lighter shade; no upturned, bifid process arising from the apex of the 10th abdominal segment (except in the species last in our list); the superior abdominal appendages of the male not strongly directed downward and inward............................ Enallagma

dd Sexes strikingly unlike in color; a bifid process arising from the apical margin of the 10th abdominal segment in the male and the superior abdominal appendages strongly directed downward and inward

e Males chiefly green and black, with normal rhomboidal pterostigma; females with the orange of the abdomen covering something less than the three basal segments (becoming wholly densely pruinose with age)..................... Ischnura

ee Males yellow or orange, with ovoid stigma which does not reach the costal vein; females with the four basal segments of the abdomen yellow or orange. Anomalagrion

Nymphs

a Labium with no raptorial setae on the mentum within; gills broad, thick, dark colored, oval or oblong in shape and obtuse at apex .... Argia

aa Labium with mental setae; gills thinner, more pointed and narrower [pl.15]

  b Hind angles of the head strongly angulate

    c Gills widest beyond the middle; body slender; head half as long as wide............... Chromagrion

    cc Gills widest across the middle; body stouter; head nearly as long as wide............. Amphiagrion

  bb Hind angles of the head rounded

    d Labium with one mental seta (and a rudimentary second one) each side; antennae six-jointed; lateral lobe of the labium with the distal end above the end hook hardly denticulated .... Nehallennia

    dd Labium with three to five mental setae each side (one may be smaller than the others), and end of lateral lobe denticulated distinctly; antennae seven-jointed (with the possible exception of E. antennatum)

      e Gills more than half as long as the abdomen, lanceolate; third segment of antennae less than a third longer than the second

        f Labium with four to six lateral setae, generally with five, and with three (rarely four) mental setae each side; gills often with a definite color pattern............ Enallagma

        ff Labium with five or six lateral setae, and with four mental setae each side; gills generally with no distinct pattern....... Ischnura

      ee Gills less than half as long as the abdomen, narrower and with a long tapering point; third segment of antenna more than a third longer than the second.....Anomalagrion

ARGIA

This is another large genus whose species are nearly all American, and whose habitat is chiefly tropical or subtropical. In New York State are recorded five species, and a sixth is regional and is included in this list. Of these six, four have been bred, and their nymphs are here described for the first time.

In habits our species are somewhat diverse. In general, it may be said that they frequent the borders of the larger bodies and streams of water, and both in the water and out of it after transformation they cling to the surfaces of stones, piers, timbers, bare banks, etc., rather than to vegetation. Imagos may be found squatting on a bare bank much more frequently than clinging to its neighboring plants, but they will travel out among the plants when foraging, following then by preference a bare path or roadway.

The eggs are deposited mostly on the alga-covered surfaces to which the nymphs will afterward cling. In ovipositing the male usually retains his hold on the prothorax of the female, and when, as happens frequently with the first species of our list at least, she descends beneath the surface of the water to place her eggs at a lower level, he is carried along.

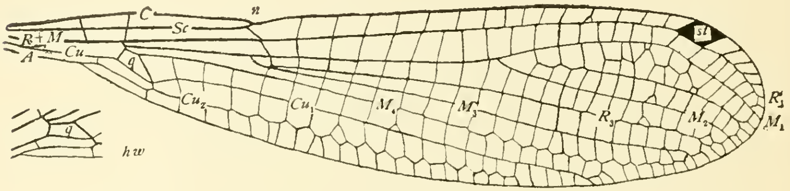

Fig. 8 Fore wing of Argia fumipennis, with quadrangle (*q*) of hind wing

The nymphs of Argia are usually recognizable at a glance, by reason of their thick set bodies and short, broad and dark colored gills. If these be not sufficient, the entire absence of raptorial setae from the mentum of the labium will certainly distinguish them from all our other genera of Agrioninae. The nymphs are so much alike that a generic description of them may be given here, saving much repetition.

Nymph. Short and thick and usually dark colored, with short legs and short-oblong gill plates [pl.15, *a*]. The head is somewhat wider than long, flat above, with very prominent eyes, behind which the sides are parallel as far as the obtusely rounded hind angles, between which is a deep round posterior emargination. The antennae are six to seven jointed, with the third joint longest. The labium [pl.14, *e* and *f*] is short, with hinge barely reaching posteriorly to the base of the middle legs; the mentum is less than a third longer than wide; median lobe spinulose on its prominent free border; no mental setae; lateral setae one to four; lateral lobe short, half as wide as long, with short, stout, movable hook and small end hook separated by a more or less distinct notch from the inner margin, and with one or more smaller teeth on the distal end above the end hook.

Prothorax pointed anteriorly and fitting the rear emargination of the head. Mesothorax and metathorax much thicker, with the wings borne at a considerable elevation. Legs short, usually banded transversely, and bearing spines as well as hairs.

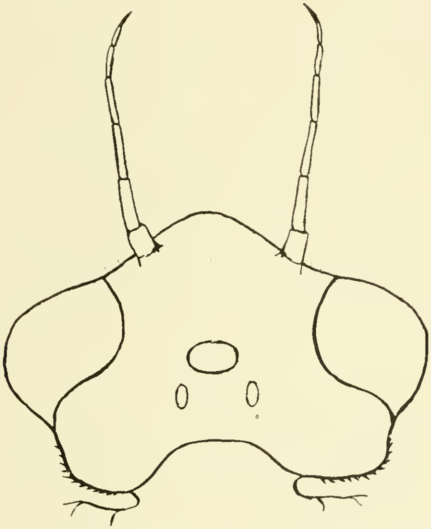

Fig. 9 Outline of head of nymph of Argia apicalis

Abdomen stout, somewhat tapering, and with its segments decreasing in length to the ninth, the tenth again a little longer. Gills oblong about half as long as wide, obtuse at apex and generally with paler apical markings. Among alcoholic specimens frequently, and among fresh specimens occasionally, the gills are absent, being easily broken off. If their loss occur early in nymphal life, they are regenerated, and it is no uncommon thing to find a specimen with one, two or three of the gill plates of smaller size than the normal. The loss of the gills seems not to affect seriously the respiration of the nymphs.

The following keys will serve for the separation of our species.

KEY TO THE SPECIES

Imagos

a Dorsum of the apical segments of the abdomen of the male blackish; pterostigma surmounting more than one cell, i. e. longer than the cell behind it.................................... putrida

aa Dorsum of apical segments of abdomen of male with blue restricted to W-shaped basal marks on segments 8 and 9; stigma generally surmounting somewhat more than a single cell.. translata

aaa Abdominal segments 9 and 10 blue, 1–7 black..... tibialis

aaaa Abdominal segments 8, 9 and 10 blue, 1–7 ringed with blue or violet

- *b* Colors light blue and black: humeral stripe of black very narrow, a mere line, suddenly widened at its lower end...................... apicalis
- *bb* Colors deep blue and black, humeral stripe of black very broad, broader than the preceding stripe of blue...............................bipunctulata
- *bbb* Colors violet and black; humeral stripe bifid superiorly, the posterior fork not reaching the alar carina................................. violacea

Nymphs

a With a single very minute lateral raptorial seta........ putrida

aa With three or four well developed lateral setae

- *b* With three well developed lateral setae (occasionally, a rudimentary fourth in apicalis)
  - *c* Median lobe of labium one third as long as it is wide apicalis
  - *cc* Median lobe of labium one fourth as long as it is wide violacea
- *bb* With four well developed lateral setae................ tibialis

aaa Unknown.....................bipunctulata and translata

Argia putrida Hagen

1861 Agrion putridum Hagen, Synopsis Neur. N. Am. p.96

1865 Argia putrida Selys, Acad. Belg. Bul. (2) 20:385

1893 Argia putrida Calvert, Am. Ent. Soc. Trans. 20:232

1896 Argia putrida Kellicott, Cincinnati Soc. Nat. Hist. Jour. 18:110 (observations on manner of oviposition)

1895-97 Argia putrida Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Niagara, Ithaca, Schoharie and Buffalo)

1899 Argia putrida Kellicott, Odon. Ohio, p.23 (description and habits)

1900 Argia putrida Williamson, Dragon Flies Ind. p.261 (description and habits)

1902 Argia putrida Williamson, Ent. News, 13:67 (oviposition; feeding, fig. of eggs on pinnule of Osmunda.

This is our largest species. It was not common at Saranac Inn, though a few could be found at any time about the timbers by the shores of the larger ponds. I bred it there. I had previously bred it at Ithaca, where it is very common, and during the summer of 1901 I bred from Fall creek many additional examples. The species is a common and characteristic one about the shores of the great lakes. It belongs on wave-beaten shores and in the larger and more rapid streams. In Fall creek its nymphs are found under stones in even the swiftest water, clinging, as stone flies cling, to the rocks. It is the only dragon fly to be found inhabiting such situations.

Kellicott made some interesting observations on the species at Lakeside on Lake Erie. The species was ovipositing in pairs on the dock timbers. The females would sometimes descend the timbers into the water, carrying the males with them. The females would remain submerged a long time (once almost an hour) while ovipositing, but the males would disengage themselves and come up out of the water after 5 to 20 minutes. The descent is made by the backing downward of the female as she reaches ever for new territory in which to distribute her eggs.

Nymph. Length 17mm, gills 6mm additional, abdomen 10mm; width of head 4mm. Antennae seven jointed, the second joint one third longer than the first. The single raptorial seta of the lateral lobe of the labium is very minute, difficult to see at all. The median lobe of the labium is very prominent, about half as long as it is wide. In the center of the mentum is an elongate V-shaped chitinization, the V opening forward. The abdomen is relatively long, the wing cases reaching scarcely to the base of the fourth segment. The gills are more than twice as long as wide, with parallel margins and obtuse apexes, blackish, with the apical fifth more or less covered with white.

The head is more depressed, and the legs are more sprawling than in other species, due perhaps to the habitat. The stone flies and May flies living in rapids are modified in form along the same lines. At transformation the nymphs depart farther from the water than in the other species, often going several yards up the banks.

The seasonal range for imagos of this species is from May till October.

Argia apicalis Say

Plate 17, fig. 1

1839 Agrion apicalis Say, Acad. Nat. Sci. Phila. Jour. 8:410
1861 Agrion apicale Hagen, Synopsis Neur. N. Am. p.91
1893 Argia apicalis Calvert, Am. Ent. Soc. Trans. 20:233
1898 Agrion apicalis Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1899 Argia apicalis Kellicott, Odon. Ohio, p.26 (description)
1900 Argia apicalis Williamson, Dragon Flies Ind. p.264

This species I did not find either at Saranac Inn or at Ithaca, but I bred it in 1895 at Galesburg Ill., and in 1896 at Havana Ill. At Galesburg it was exceedingly abundant on the clayey banks of a rather deep woodland pond; at Havana it is exceedingly abundant at the mouth of the Spoon river, and on the west bank of the Illinois river below that point. On the sandy east bank of the Illinois river I did not observe it at all.

Imagos when fully mature are of a very bright, beautiful blue color, unobscured by pruinosity, as in the last species. But they are long in attaining their full coloration, and teneral specimens are of a pale flesh tint. I observed the imagos, both teneral and mature, at Galesburg feeding voraciously on adult Chironomids. Transformation takes place on some bank or projecting timber within a few inches of the edge of the water.

Nymph. Length 12.5mm, gills 5mm additional, abdomen 8mm; width of head 3.1mm. Antennae six-jointed. Lateral setae three, occasionally four, but then the fourth is much smaller than the others. Median lobe of labium with a median Y-shaped chitinization, the arms of the Y projecting forward. Gills half as wide as long, with margins parallel for a distance, usually showing a paler transverse streak at three fourths their length. Wing tips reaching well across the sixth abdominal segment.

Nymphs of this species kept in an aquarium at Galesburg intermittently swayed the abdomen from side to side, apparently as an aid to respiration; yet other nymphs in the same aquarium, having lost their gills, did not seem to suffer in consequence, though kept for weeks, and finally transformed into perfect specimens.

Argia violacea Hagen

Plate 13, fig. 4, 5

1861 Agrion violaceum Hagen, Synopsis Neur. N. Am. p.90
1893 Argia violacea Calvert, Am. Ent. Soc. Trans. 23:233

1893-95 Argia violacea Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Keeseville, Dobbs Ferry, Ithaca and Buffalo)
1899 Argia violacea Kellicott, Odon. Ohio, p.25 (description)
1900 Argia violacea Williamson, Dragon Flies Ind. p.262 (description)
1901 Argia violacea Needham, N. Y. State Mus. Bul. 47, p.402, 405, 407 (occurrence at Saranac Inn)

This species is one of the most generally distributed in the northeastern United States. In habitat it approaches species of Lestes and Enallagma, dwelling by ditches and slow streams, and in the bays of larger bodies of standing water. The beautiful violaceous color of the adult males in life is fairly distinctive of the species, and has suggested the specific name.

This species like the preceding oviposits commonly in mats of algae lying at the edge of the water, or covering floating vegetation. On such mats I have frequently seen many females at work side by side, each with a male clasping her prothorax with his forceps, his body sticking up straight in air, his legs and wings placidly folded. This curious position, standing, as it were, on the tip of the abdomen, is assumed, I think, not so much on account of the male trying to avoid the water, as Kellicott has suggested,[1] as on account of the greater ease of maintaining this position. The inferior appendages of the male are so much longer than the superiors that were the male to remain with his feet on the ground, when the female depresses her abdomen in ovipositing, the flexion of his body would be extreme, and perhaps uncomfortable. At any rate, he takes the elevated position very philosophically, folds his legs and waits till his spouse gets ready to let him down; and, when she wants to move from place to place, he uses his wings to help her.

Nymph. Length 10mm, gills 4mm additional, abdomen 6mm; width of head 3mm. Antennae six jointed. Median lobe of labium less prominent than in the other species. Lateral setae three. Wings reaching well on the sixth abdominal segment. Gills ovate broadly, obtuse, with the margins hardly parallel anywhere, an obscure transverse paler streak at three fourths their length.

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[1] Cincinnati Soc. Nat. Hist. Jour. 17:203

The nymphs found in Little Clear creek, where most abundant, were often deeply incrusted with a reddish brown deposit, and in July many of them were further decorated with a number of living red hydras attached to their backs, as shown on plate 13, figure 5.

Argia tibialis Rambur

Plate 15, *a*

1842 Platycnemis tibialis Rambur, Ins. Neur. p.241
1861 Trichonemis tibialis Hagen, Synopsis Neur. N. Am. p.72
1865 Argia tibialis Selys, Acad. Belg. Bul. (2) 20:413
1893 Argia tibialis Calvert, Am. Ent. Soc. Trans. 20:233

This species is not yet known from New York State, but it has been reported from Pennsylvania, and may be found here also. Its range extends westward and southward to Illinois and Texas. I have a number of specimens that were bred by Mr F. G. Schaupp at Shovel Mount Tex., between Aug. 13 and Aug. 18, 1898. From the cast skins, and from a few additional specimens apparently belonging to the same species, I have drawn the following brief descriptive characters.

Nymph. Length 12mm, gills 4.5mm additional, abdomen 8mm; width of head 3.2mm. Color greenish or brownish, marked with darker in a double row of elongate spots on the dorsum of the abdomen, and in two faint transverse bands on each femur. Structurally it differs from the preceding species only in the following points: there are four lateral setae on the labium, in a regular series; the end hook of the lateral lobe is not separated from the inner margin by an incision; the tooth on the end above the end hook is smooth and not denticulated superiorly; the gills are ovoid oblong, widest just beyond the middle and rather abruptly rounded on the tip, and they show hardly any area of lighter color apically. Antennae six jointed; other characters as in the preceding.

Argia bipunctulata Hagen

1861 Agrion bipunctulatum Hagen, Synopsis Neur. N. Am. p.90
1865 Argia bipunctulata Selys, Acad. Belg. Bul. (2) 20:415
1893 Argia bipunctulata Calvert, Am. Ent. Soc. Trans. 20:234

This species is recorded from New Jersey, but is not yet known from New York State. Its nymph is still unknown.

Argia translata Hagen

1865 Argia translate Hagen, Acad. Belg. Bul. (2) 20:410
1901 Argia translata Calvert, Ent. News. 12:326 (recorded from New York State)

This species, discovered in our State by Dr Calvert at White Lake, Sullivan co., Aug. 2, 1898, was previously recorded only from Venezuela. Its nymph is unknown.

CHROMAGRION gen nov.

Since the repartition of the old genus Agrion in 1876, the North American Agrion conditum of Hagen has generally been written ?Erythromma conditum, its affinity with Erythromma being doubtful on account of notable differences in venation, in form of abdominal appendages and in type of coloration between this species and the typical species of the genus. The discovery of the nymph now gives opportunity for comparison of nymphal characters; the differences here are equally noteworthy. A tabular comparison of the principal characters of the nymph of our species with the nymphs of typical species of Erythromma and Pyrrhosoma (the only genera with affinities close enough to make such comparison necessary) will make clear the reasons (added to the well known differences of imagos) for proposing the establishment of a new genus.

CHARACTER OF NYMPH	CHROMAGRION (A. conditum type)	ERYTHROMMA	PYRRHOSOMA
Hind angles of head	strongly angulate	strongly angulate	rounded
Gills	long and narrow, widening almost to the tip, then suddenly contracted, then pointed	broad, oblong with parallel sides, obtusely rounded on tip	oblanceolate, contracted near tip and then pointed
Mental setae of labium	3 and a rudimentary 4th	3–4, usually 4	1, and a rudimentary 2d
Lateral setae	5	6–7	7–8
End of lateral lobe of labium, above end hook	squarely truncate, angled superiorly scarcely denticulate	less square, with 3 strong teeth	obliquely truncate, rounded superiorly and not denticulate

In addition to the differences in coloration and appendages clearly stated by de Selys as distinguishing this species from the typical erythromma, there are differences of venation which may be indicated by tabular comparison:

CHARACTER	ERYTHROMMA	CHROMAGRION
Anterior side of the quadrangle	shorter (f. w.) or equal (h. w.) to the inner side	2 (f.w.) to 2½ (h.w.) times the length of the inner (proximal) side
Anal vein separating from the hind margin	much before the vertical cubitoanal cross vein	just before or opposite the obliquely placed cubitoanal cross vein
Vein M_4 beginning to be angulate (f. wing)	opposite the origin of vein M_2	4-5 cells beyond the level of the origin of vein M_2, and near the level of the stigma
Areoles behind vein Cu_2	wider than long	longer (in the axis of the wing) than wide

Chromagrion conditum Hagen

Plate 13, fig. 1-3

1876 ?Erythromma conditum Hagen, Acad. Belg. Bul. (2) 41:1305

1893 ?Erythromma conditum Calvert, Am. Ent. Soc. Trans. 20:234

1895-97 Erythromma conditum Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Ithaca and Hamburg)

1899 Erythromma conditum Kellicott, Odon. Ohio, p.28

1900 ?Erythromma conditum Williamson, Dragon Flies Ind. p.265

My first morning at Saranac Inn (June 14, 1900) I went out before breakfast along the southwest side of the outlet of Little Clear pond, and found in a little trashy bay near the pond Tetragoneuria spinigera, Ladona julia, Leucorhinia glacialis and this species all transforming together. Later, I found nymphs of Cordulia shurtleffi in the same shallows. Chromagrion transformed perhaps a little farther out from shore than any of the others, clambering up the projecting twigs of small trees that had been felled in the edge of the pond outlet, and transforming a few inches above the surface of the water.

Previously I had found the species, likewise in transformation, at MacLean N. Y., when on May 30, 1897, in company with Mr A. D. MacGillivray, I went on a collecting trip from Ithaca thither. There it inhabited a spring-fed pool near the banks of Fall creek. Specimens in all stages were picked from the culms of the grasses and sedges standing in the pool.

The imagos appear to keep rather close to shelter and to their native shallows, spending but little time on the wing. Transformation takes place for the most part in the morning or early forenoon, and the place selected is at most but a few inches above the water. The species is of wide distribution, but is everywhere quite local. Imagos will be readily recognized from the unique combination of blue and yellow on the thorax, shown on plate 13, figure 2.

Nymph. Measures in length 12mm, gills 6mm additional. Color greenish brown, paler beneath, marked with darker brown on frons, hind angles of the head sides of thorax and middle of abdominal segments; legs with two darker transverse bands on the femora and a less distinct, basal one on all tibiae; gills greenish brown, with a series of darker points along the spinose margins and with paler apexes.

Body slender; head wide, with large and strongly angulate hind angles and a deep posterior notch between them; antennae seven jointed. Labium rather short, the hinge reaching posteriorly between, but not beyond, the bases of the fore legs. Median lobe moderate; mental setae three each side; lateral setae five. Thorax narrower than the head. Legs slender, very scantily hairy, but with a double inferior row of spines. Wings reaching posteriorly well on the base of the fifth abdominal segment. Abdomen with sides parallel, or very little tapering toward the tip. Gills narrowly oblanceolate, widest at four fifths their length.

AMPHIAGRION

A single species falls within the limits of our fauna.

Amphiagrion saucium Burmeister

Plate 18, fig. 1-3; plate 15, *c*

1839 Agrion saucium et A. discolor Burmeister, Handb. Ent. 2:819.

1876 Amphiagrion saucium Selys, Acad. Belg. Bul. (2) 41:285

1890 Amphiagrion discolor Kirby, Cat. Neur. Odon. p.143

1893 Amphiagrion saucium Calvert, Am. Ent. Soc. Trans. 20:235

1895–97 Amphiagrion saucium Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Westchester county, Ithaca, Karner and Buffalo)

1898 Amphiagrion saucium Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)

1899 Amphiagrion saucium Kellicott, Odon. Ohio, p.31

1900 Amphiagrion saucium Williamson, Dragon Flies Ind. p.267

This is a meadow-rivulet-loving species. I have found it in a number of localities, but only in very small, reed-choked, spring-fed brooks. The imagos, which will at once be recognized by their deep red color, are found only in the vicinity of their native streamlet, where they flit about chiefly among the stems in or overhanging the water.

In 1896 I located the species in a small meadow brook near the head of Lake George at Galesburg Ill., but too late for rearing it that season. The following year, having removed to New York, I requested Dr W. E. Castle, then living in Galesburg, to collect and rear the nymphs. This he did, securing the first transformation of a specimen June 2, 1897. To Dr Castle, therefore, belongs the credit for material for this life history. Further specimens of the nymphs from the same brook were sent me afterward by Mr G. B. Smith of Knoxville Ill., and I have since received others from various points in the West. The nymph is at once recognized among related forms by its thickset body and the remarkably prominent hind angles of the head.

Nymph [pl.18, fig.3]. Measures in length 11mm, gills 4mm additional. Color brownish, paler on antennae and on sutures; eyes and a divided median line on the thorax black; abdomen with lateral margins pale; a black point above and another below this line toward the apex of each segment; gills pale, with a series of black dashes along the axis; tibial spines and apexes of all leg segments and claws brown.

Body and legs short and thick. Head quadrangular, hardly wider than long, with prominent, well rounded eyes and behind them strongly projecting, squarely cut hind angles; middle third of hind margin of head deeply excavated; ocelli very evident.

Prothorax closely fitted into excavation of rear of head. Antennae six jointed. Labium short, mentum a third longer than wide, considerably contracted at the base; median lobe not very prominent, serrulate on margin, with short, incurved, flattened microscopic scales arising between the serrulations; mental setae four each side, lateral setae five (in one case six); end hook stout, arcuate, short, above which, on the distal margin of the lateral lobe and separated from the hook by a deep notch, are five minute teeth decreasing in size externally. Thorax narrower than head, wing cases reaching the base of segment 5 of abdomen; segments of the abdomen short, somewhat tapering to apex. Gills [pl.15, *c*] more than half as long as abdomen, lanceoval, widest in the middle, the superior border more convex than the inferior specially in the two lateral gill plates.

NEHALLENNIA

Two delicate bronzy green species are included in our fauna. One is widely distributed and well known; the other has not been hitherto reported from the State. These are among the most highly specialized of the Agrioninae, as evidenced by the reduced wing venation, the skewness of the thorax, the slenderness of the body, and the color. Reedy places in still water, specially places of springs and bogs, are their favorite haunts. I have bred our common species N. irene, and describe its nymph below; the nymph of N. gracilis is unknown. The imagos may be distinguished as follows:

a Apex of the abdomen of the male with bronzy green lateral triangles laid on the blue of segments 8–10; hind margin of prothorax of female trilobed........................ irene
aa Apex of abdomen of male all blue on segments 9 and 10, and on segment 8 except a narrow basal ring; hind margin of prothorax of female bilobed......................gracilis

Nehallennia irene Hagen

Plate 18, fig. 4, 5

1861 Agrion irene Hagen, Synopsis Neur. N. Am. p.74
1876 Nehallennia irene Selys, Acad. Belg. Bul. (2) 41:1240
1893 Nehallennia irene Calvert, Am. Ent. Soc. Trans. 20:234
1895 Nehallennia irene Calvert, N. Y. Ent. Soc. Jour. 3:43 (listed from Ithaca)
1899 Nehallennia irene Kellicott, Odon. Ohio, p.29
1900 Nehallennia irene Williamson, Dragon Flies Ind. p.265

This species is common about swales, springs and bogs in shallow reedy waters, associated with the bronzy green species of the genus Lestes, which dwell in the same situations. It is exceedingly common at Lake Forest Ill., where I bred a number of specimens June 7 and 8, 1899.

Nymph. Measures in length 12mm, gills 4 to 4.5mm additional; width of head 2.5mm. Color greenish, with faint brownish rings on the femora and five pairs of indistinct spots ranged along the margins of each gill lamella.

Head much wider than long, strongly narrowed behind the very prominent eyes to well rounded hind angles, whose curve is exactly the reverse of the concavity of the excavation of the hind margin between the hind angles. Legs slender, smooth; wing cases reaching the middle of the fourth abdominal segment. Gills [pl.15, *d*] lanceolate, pointed, widest a little beyond the middle, with more or less distinct small, marginal spots.

Antennae six jointed, the six joints having the following relative lengths:—1:2:3:2:1.7:2. Labium slender, the hinge reaching posteriorly about to the bases of the middle legs. Mentum not abruptly narrowed to the hinge, but with the lateral margins somewhat sinuate in outline. Mental setae 1 (and a rudiment) each side; lateral setae six each side. The end of the lateral lobe [pl.14, *i*] above the end hook not denticulate as in all the other genera.

Nehallennia gracilis Morse

1895 Nehallennia gracilis Morse, Psyche, 7:274

This species, hitherto reported from but two localities in Massachusetts, was common at Saranac Inn about the edges of Little Bog pond, where it was associated with N. irene, Lestes eurina, L. uncata, Cordulia shurtleffi, and Dorocordulia libera, a notable assemblage of bronzy greens. It swarmed about the edges of the clumps of lambkill, and could be taken anywhere by sweeping with a net the sedges and cotton grass that grew on the sphagnum beds. I regret I did not observe at the time that I was collecting anything but N. irene; and, having already bred that species, I made no effort to get the nymph of this one.

ENALLAGMA

This is the dominant genus among our Zygoptera. Twelve species have been recorded hitherto from the State; two other species (piscinarium and pollutum) are here recorded, and several other species are regional. These frequent all sorts of fresh water, being most abundant where there is much submerged and floating vegetation. They dwell in still and shallow water.

The imagos spend most of their time over the surface of the water, flying from leaf to leaf, or from one mat of floating algae to another. They fly very low, some species so low that it is well nigh impossible to get a collecting net under them without dipping the water. In foraging they fly through the vegetation—not over it, and do not often depart very far from the borders of the water. They flit easily about among the grass stems, where their bands of alternating brilliant blue and black are singularly inconspicuous, and they settle oftenest in a rigidly horizontal position on the perpendicular culms. So far as I have observed, their food is the small Diptera Chironomidae etc., which swarm in such places. They are eaten in numbers by cricket frogs, which lie in ambush amid the floating algae, and catch them when they come to mate and oviposit; by swallows, which can skim close enough to the water to get them, and they are snared in spider's webs, and are eaten by other damsel flies, specially by species of Lestes, as I have observed.

The eggs are deposited in punctures in the tissues of green plants just beneath the surface of the water. Floating leaves seem to be preferred, but, where these are absent, or too few, the stems of standing aquatics are often found thickly punctured, and filled with eggs in all stages of development. They generally fly in pairs and oviposit in *copulo*, but they do not, so far as I have observed, descend beneath the surface of the water in ovipositing.

The nymphs live in tangled, submerged vegetation, and are among the most numerous of the predatory hordes in such situations. They are protectively colored with green and brown, the proportion of each color varying somewhat with that of the surrounding vegetation. When grown, they crawl barely out of the water to transform. In places where there is more submerged than exposed vegetation, after a period of transformation, the exposed stems may often be found encircled with a mass of empty skins, clinging one above another where they have been left in a great accumulation, many layers deep.

It is highly probable that not all the species of the following enumeration will prove entirely distinct; but they have not yet been studied and collected sufficiently for the determination of this matter. It would be utterly impossible at present to give a key that would distinguish females, and a key for the males based on coloration would have to be offered tentatively, since the range of variability in color pattern has not been determined. Instead of attempting a key, I have thought best to present herewith drawings of the appendages of the male of all species known from the State, these being the surest criteria for the recognition of the species. The males can then be determined by comparison with the figures, and the females can be kept with the males with which they are found associated in nature.

As is to be expected in such a genus, the nymphs are very much alike. A brief general description here will therefore save much repetition in treating of the species.

Nymph. The nymph of Enallagma is slender, nearly smooth, with the head a third wider than succeeding parts of the body (the excess of width being wholly due to the lateral prominence of the eyes), and with abdomen very slightly tapering posteriorly. The head is one half wider than long, with frons moderately prominent, broadly rounded hind angles, and a wide posterior excavation between them. Antennae long, slender, seven jointed, the segments increasing in length to the third, and decreasing thereafter to the tip. Legs slender, nearly smooth, often banded with brown. Wing cases reach posteriorly to the middle of the fourth abdominal segment. Abdomen cylindric, its segments decreasing a very little both in length and in diameter toward the apex. Gills lanceolate, pointed, with variable color pattern.

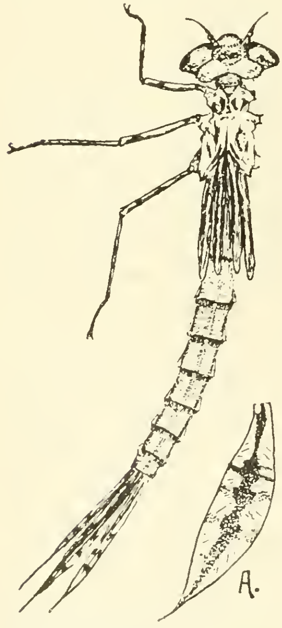

Fig 10 The nymph of Enallagma signatum: *A*, lateral view of median gill lamella.

Labium slender, with prominent median lobe, lateral lobes upcurved at their external margins; mental setae two to four each side. Lateral setae four to five each side. Lateral lobe with a moderate movable hook and an arcuate end hook and several small teeth on the distal end above the latter, of variable proportions.

Enallagma durum Hagen

1861 Agrion durum Hagen, Synopsis Neur. N. Am. p.87
1893 Enallagma durum Calvert, Am. Ent. Soc. Trans. 20:236, pl.3, fig.32

A species that is apparently not common in its range. It is recorded by Dr Calvert from Rhode Island and New Jersey, but it has not yet, apparently, been taken in New York State. Its nymph is unknown.

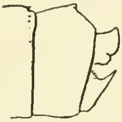

Fig. 11 Lateral view of end of abdomen of Enallagma durum, ♂

Enallagma annexum

Plate 19, *a*

1861 Agrion annexum Hagen, Synopsis Neur. N. Am. p.87
1893 Enallagma cyathigerum, *var.* annexum Calvert, N. Y. Ent. Soc. Jour. 3:43 (listed from Keeseville and Ithaca)
1900 Enallagma annexum Williamson, Ent. News. 11:454, pl.9, fig.5, 9, 10 and text figure (characters and distribution)

A species with northward distribution. It was collected at Saranac Inn throughout July.

Enallagma hageni Walsh

Plate 19, *b*

1862 Agrion n. sp. Walsh, Acad. Nat. Sci. Phila. Proc. p.386
1863 Agrion Hageni Walsh, Ent. Soc. Phila. Proc. 2:234
1893 Enallagma hageni Calvert, Am. Ent. Soc. Trans. 20:237, pl.3, fig.22, 23
1895–97 Enallagma hageni Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (recorded from Ithaca, Lake Bluff, Lake Pleasant, Albany and Squaw island)
1899 Enallagma hageni Kellicott, Odon. Ohio, p.39, fig.10
1900 Enallagma hageni Williamson, Dragon Flies Ind. p.269, pl.15, fig.1, 2

A species widely distributed in the eastern United States, and often locally very abundant. It is common at Ithaca about the Cascade pond during July, and about the hatchery grounds at Saranac Inn during the same month. I have bred the species at the following dates and places: Lake Forest Ill. May 31, 1899; Saranac Inn N. Y. July 15, 1900.

Nymph. Length 13mm; gills 4.5mm additional. Mental setae three each side. Lateral setae five each side. End hook of lateral lobe of labium preceded by three teeth of moderate size, that are preceded by three others very minute. Gills with scanty and diffuse pigmentation along the axial trachea in its basal two thirds.

Enallagma geminatum Kellicott

Plate 19, *c*

1895 Enallagma geminatum Kellicott, Ent. News, 6:239
1899 Enallagma geminatum Kellicott, Odon. Ohio, p.40, fig.11
1900 Enallagma geminatum Williamson, Dragon Flies Ind. p.272, pl.5, fig.11, 12 (recorded from New York)

This is a little species, which flies habitually within half an inch of the surface of the water, and is hard to get a net under. It appears to occur sparingly in New York State, but is abundant westward. I bred it at Havana Ill. in June 1896, at which time and place it was exceedingly abundant.

Nymph. Length 13mm, gills 4mm additional. Mental setae four (occasionally three) each side. Lateral setae five. Two minute teeth on the end of the lateral lobe, preceding the three usual larger ones before the end hook. Gills shorter than usual, and practically without pigmentation.

Enallagma divagans Selys

Plate 19, *e*

1876 Enallagma divagans Selys. Acad. Belg. Bul. (2) 41:521
1893 Enallagma divagans Calvert, Am. Ent. Soc. Trans. 20:238, pl.3, fig.15, 16
1899 Enallagma divagans Kellicott, Odon. Ohio, p.43, fig.12
1900 Enallagma divagans Williamson, Dragon Flies Ind. p.273, pl.5, fig.15, 16

This species is recorded from Massachusetts and Pennsylvania, but has not, apparently, been taken as yet in New York State. Its nymph is unknown.

Enallagma piscinarium Williamson

Plate 19, *d*

1900 Enallagma piscinarium Williamson, Dragon Flies Ind. p.273, fig.13, 14

This species was taken several times during July 1901 at Ithaca, by Mr H. N. Howland, Mrs O. A. Johannsen, and myself.

It was taken by Mrs Johannsen in an orchard in a city lot a considerable distance from water. The nymph is unknown.

Enallagma exsulans Hagen

Plate 16, fig. 2; plate 19, *f*

1861 **Agrion exsulans** Hagen, Synopsis Neur. N. Am. p.82
1893 **Enallagma exsulans** Calvert, Am. Ent. Soc. Trans. 20:238, pl.3, fig.29
1895-97 **Enallagma exsulans** Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (listed from Keeseville, Saratoga lake, Ithaca, Black Rock)
1899 **Enallagma exsulans** Kellicott, Odon. Ohio, p.42, fig.1
1900 **Enallagma exsulans** Williamson, Dragon Flies Ind. p.274, pl.5, fig.17, 18

This is an exceedingly common species over the larger part of the eastern United States. At Ithaca it abounds everywhere. At Saranac Inn I found it most common about the trashy borders of the deeper ponds. I have bred the species at the following dates and places: Saranac Inn July 8, 1900, Galesburg Ill. June 30, 1895.

Nymph. Length 14.5mm, gills 4.5mm additional. Mental setae two or three on each side; lateral setae four or five. Three minute teeth preceding the normal three larger ones on the end of the lateral lobe above the end hook. Gills lanceolate but not very sharply pointed, pigmented in two transverse bands and along the axis and sometimes slightly around the margin.

Enallagma ebrium Hagen

Plate 19, *g*

1861 **Agrion ebrium** Hagen, Synopsis Neur. N. Am. p.89
1895-97 **Enallagma ebrium** Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Keeseville, Ithaca, Schoharie and the Catskills)
1899 **Enallagma ebrium** Kellicott, Odon. Ohio, p.34, fig.5
1900 **Enallagma ebrium** Williamson, Dragon Flies Ind. p.270, pl.5, fig.3, 4

An abundant species in the Cascade pond at Ithaca, but I have neglected to rear it. Its nymph is unknown.

Enallagma carunculatum Morse

Plate 17, fig. 2; plate 19, *h*

1895 **Enallagma carunculatum** Morse, Psyche, 7:208
1895-97 **Enallagma carunculatum** Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from Niagara, Lake Pleasant and Piseco lake)

1898 Enallagma carunculatum Needham, Outdoor Studies, p.62, fig.62
1899 Enallagma carunculatum Kellicott, Odon. Ohio, p.38, fig.14
1900 Enallagma carunculatum Williamson, Dragon Flies Ind. p.270, pl.5, fig.7, 8

I bred this species at Havana Ill. July 10, 1896, where it was common about the banks of the Illinois river. It is a robust and handsome species, of somewhat stronger flight than most of its congeners.

Nymph. Length 15mm, gills 5mm additional. Mental setae three each side, laterals four to six, usually five. The three minute teeth on the end of the lateral lobe graduate into the three larger ones abutting on the end hook. Gills lanceolate, pointed, diffusely pigmented along the axis to near the tip.

Enallagma civile Hagen

Plate 19, *i*

1861 Agrion civile Hagen, Synopsis Neur. N. Am. p.88
1876 Agrion canadense Provancher, Nat. Canadienne, 8:125
1888 Enallagma civile Kolbe, Arch. f. Naturg. 44:170
1893 Enallagma civile Calvert, Am. Ent. Soc. Trans. 20:236, pl.3, fig.31
1895–97 Enallagma civile Calvert, N. Y. Ent. Soc. Jour. 3:43 and 5:92 (listed from "New York")
1899 Enallagma civile Kellicott, Odon. Ohio, p.37, fig.15
1900 Enallagma civile Williamson, Dragon Flies Ind. p.270, pl.5, fig.5, 6

A vigorous western species, apparently not common in New York State. Its nymph is unknown.

Enallagma aspersum Hagen

Plate 19, *j*

1861 Agrion aspersum Hagen, Synopsis Neur. N. Am. p.97
1893 Enallagma aspersum Calvert, Am. Ent. Soc. Trans. 20:237, pl.3, fig.30
1895 Enallagma aspersum Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from Long Island, Dobbs Ferry and New York city)
1895 Enallagma aspersum Morse, Psyche, 7:211
1899 Enallagma aspersum Kellicott, Odon. Ohio, p.25, fig.2
1900 Enallagma aspersum Williamson, Dragon Flies Ind. p.271

A species I have not seen at large. Its nymph is unknown.

Enallagma antennatum Say

Plate 16, fig. 4; plate 19, *l*

1839 Agrion antennatum Say, Acad. Nat. Sci. Phila. Jour. 8:39
1861 Protoneura antennata Hagen, Synopsis Neur. N. Am. p.73
1895 Enallagma fischeri Kellicott, Cincinnati Soc. Nat. Hist. Jour. 17:206
1897 Enallagma fischeri Calvert, N. Y. Ent. Soc. Jour. 5:94 (listed from Ithaca)
1900 Enallagma antennatum Williamson, Dragon Flies Ind. p.274, pl.5, fig.19, 20

In April Mr E. B. Williamson sent me from Bluffton Ind., and Mr R. J. Weith sent me from Elkhart Ind., simultaneously, nymphs (one of which is shown on plate 16, figure 4) that I suspected might belong to this species. Mr Williamson had volunteered to rear the species for me, and early in June he reported that he had done so, and that it was E. antennatum. The nymph differs from others of the genus in the striking zigzag lines of pigmentation across the eyes, in a poorer development of the mental setae of the labium and in the shape and color pattern of the gills.

Nymph [pl.16, fig.4]. Measures (not fully grown) in length 12mm, gills 5mm additional. Colors green and brown, disk of head and a middorsal longitudinal line on prothorax, narrowing posteriorly, pale; there is also an oblique pale line starting behind each eye on the sides of the prothorax. The pigmentation of the eye is in well marked zigzag lines extending horizontally. Legs pale, with subapical rings of brown on all femora. There is a narrow pale middorsal line on the abdomen and a paler wash on the lateral angles of all the segments. The antennae are but six jointed but I suspect that this may be due to immaturity; the two basal segments are brown, the remainder, pale.

Gills lanceolate, unusually long and narrow, widest just beyond the middle, obscurely marked with brown, which is deepest in shade just before the white tips.

Labium with five lateral setae, and three mentals each side, of which one is minute: thus the development of mental setae is less than in any other species at present known to me.

I have collected a single male specimen at Ithaca.

Enallagma traviatum Selys

Plate 19, *k*

1876 Enallagma traviatum Selys, Acad. Belg. Bul. (2) 41:519
1895 Enallagma traviatum Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from Long Island)

1895 Enallagma traviatum Morse, Psyche, 7:211
1899 Enallagma traviatum Kellicott, Odon. Ohio, p.36, fig.8, 9
1900 Enallagma traviatum Williamson, Dragon Flies Ind. p.271, fig. 9, 10

Another species I have not seen at large. Its nymph is unknown.

Enallagma signatum Hagen

Plate 17, fig. 2; plate 19, *m;* text figures 10, 11

1861 Agrion signatum Hagen, Synopsis Neur. N. Am. p.84
1863 Agrion dentiferum Walsh, Ent. Soc. Phila. Proc. 2:236
1893 Enallagma signatum Calvert, Am. Ent. Soc. Trans. 20:238, pl.3, fig.28
1895-97 Enallagma signatum Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (listed from New York and Williamsville)
1899 Enallagma signatum Kellicott, Odon. Ohio, p.45, fig.4
1900 Enallagma signatum Williamson, Dragon Flies Ind. p.5, fig.21, 22

To the foregoing record for this species I can add that it occurs sparingly at Ithaca. I have bred it repeatedly in Illinois in June, and have its nymph also from North Carolina.

Nymph [fig.10]. Length 14.3mm, gills 5mm additional. Mental setae three each side; laterals five, or in young nymphs four. An indistinctly denticulate lobe preceding the three well defined normal teeth on the end of the lateral lobe of the labium above its end hook. Gills elongate lanceolate, pointed, with three broad transverse well defined blackish bands connected with black on the axis, the apical one broader.

Enallagma pollutum Hagen

Plate 19, *n*

1861 Agrion pollutum Hagen, Synopsis Neur. N. Am. p.83
1893 Enallagma pollutum Calvert, Am. Ent. Soc. Trans. 20:239, pl.3, fig.27
1899 Enallagma pollutum Kellicott, Odon. Ohio, p.46, fig.13
1900 Enallagma pollutum Williamson, Dragon Flies Ind. p.276, pl.5, fig.23, 24

Though the range of this species extends from Maine to Florida and Illinois, it has not hitherto been reported from New York State. Its nymph is unknown.

Three additional species from Massachusetts, E. laterale, E. minusculum and E. pictum, described by Morse in *Psyche*, 7:207, 274 respectively, and unknown to me, may, perhaps, be counted regional.

ISCHNURA

This cosmopolitan genus contains a few very common and widely distributed and well known species. I include three in this paper, one of which I. posita, has been referred hitherto to Nehallennia. The one reason for referring it to Nehallennia, the absence of a spine on the apex of the sternum of the eighth abdominal segment in the female, appears not to be a good one, since a number of species are now referred to Ischnura lacking that spine. Ischnura and Enallagma are not very sharply defined from each other, and this troublesome species stands in some respects intermediate in characters between the

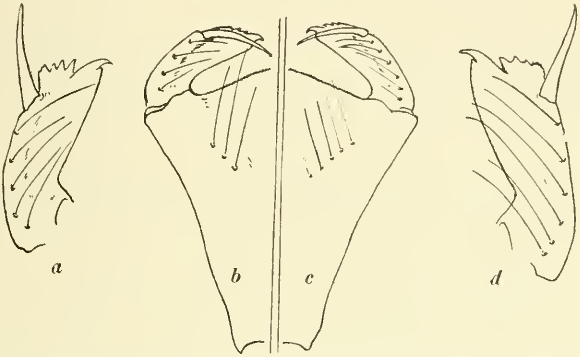

Fig. 12 Labia of Enallagma and Ischnura; *a* and *b*, labium of E. signatum; *c* and *d*, of I. verticalis

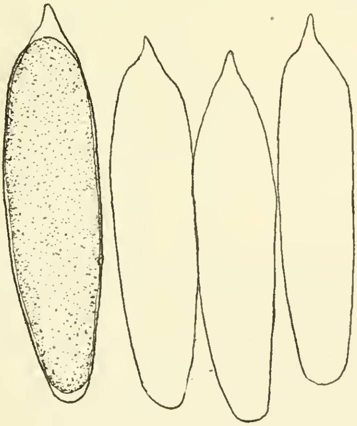

Fig. 13 Eggs of Ischnura verticalis

two; but I have here referred it to Ischnura chiefly because of the form of the abdominal appendages in the male, and the small round postocular spots. Its nymph I am not as yet able to separate from those of several species of Enallagma. I. verticalis, seems, on the contrary, to be distinguishable by the possession of six lateral setae in the nymphal labium; I have seen one specimen of E. carunculatum with this number on one side, but no other specimen of Enallagma with more than five.

The species of Ischnura appear early in spring, being often the first to be seen, and continue till late autumn, and have probably a number of overlapping broods each season. They frequent all sorts of fresh and even somewhat brackish water, and flit lightly around the shores, ovipositing in the stems of half submerged water plants, or they forage somewhat widely over the adjacent hill slopes.

The nymphs likewise occur everywhere in water in which there are stems of water plants to clamber on.

Our species may be distinguished as follows:

KEY TO SPECIES

Imagos

a Segments 8 and 9 of abdomen blue with a black stripe each side .... verticalis
aa Segment 8 of abdomen blue, 9 black.................. ramburii
aaa Segments 8 and 9 of abdomen black.................. posita

Nymphs

a Labium with six lateral setae each side............... verticalis
aa Lateral lobe of labium with five lateral setae.......... posita
aaa Unknown .... ramburii

Ischnura verticalis Say

Plate 16, fig. 5; plate 17, fig. 4, 5

1839 Agrion verticalis Say, Acad. Nat. Sci. Phila. Jour. 8:37
1861 Agrion verticalis et Agrion ramburii Hagen, Synopsis Neur. N. Am. p.76 and 82
1893 Ischnura verticalis Calvert, Am. Ent. Soc. Trans. 20:239
1895–97 Ischnura verticalis Calvert, N. Y. Ent. Soc. Jour. 3:44 and 5:92 (listed from most parts of the State)
1898 Ischnura verticalis Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)

1898 Ischnura verticalis Needham, Outdoor Studies, p.61, fig.61
1899 Ischnura verticalis Kellicott, Odon. Ohio, p.48
1900 Ischnura verticalis Williamson, Dragon Flies Ind. p.278

This pretty little species is perhaps the commonest damsel fly in North America. It is everywhere common in this State, ranges through the whole season, and is out early in the morning and flies till dusk. It will be readily recognized in the male sex by the black bars on a blue ground on the sides of the eighth and ninth abdominal segments.

I have bred the species at every station where I have done any extended collecting, and at various dates, but oftenest in June and July.

Nymph. Measures in total length 11mm; gills 5mm additional. Color greenish, paler beneath and on the sutures with darker mottlings on the top of the head, and more or less distinct subapical rings on the femora; abdominal segments with darker apical rings including a circlet of pale dots; gills hyaline with tracheae showing very distinctly and pigmentation tending to form incomplete transverse bands of blackish brown.

Antennae seven jointed. Labium with six lateral and four mental setae each side; end of lateral lobe with three distinct and strong teeth above the end hook and a denticulate angle next the movable hook.

Ischnura ramburii

1850 Agrion ramburii Selys, Rev. Odon. d'Eur. p.186
1876 Ischnura ramburii Selys, Acad. Belg. Bul. (2) 41:272
1861 Agrion iners }
Agrion tuberculatum }
Agrion credulum }
Hagen, Synopsis Neur. N. Am. p.75, 76, 80
1893 Ischnura ramburii Calvert, Am. Ent. Soc. Trans. 20:240
1895 Ischnura ramburii Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from New York)
1898 Ischnura ramburii Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)

A species apparently with coastwise distribution. Its nymph is unknown.

Ischnura posita Hagen

1861 Agrion positum Hagen, Synopsis Neur. N. Am. p.77
1867 Nehallennia positum Selys, Acad. Belg. Bul. (2) 41:1242
1893 Nehallennia posita Calvert, Am. Ent. Soc. Trans. 20:235

1898 Nehallennia posita Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1899 Nehallennia posita Kellicott, Odon. Ohio, p.30
1900 Nehallennia posita Williamson, Dragon Flies Ind. p.266

This species is of wide distribution, and is probably much more common than our present records indicate. It has hitherto been reported only from Staten Island. I have taken it at Ithaca. I bred a single specimen at Galesburg Ill. in June 1896. The cast skin is lacking in gills, and is distinguishable from that of I. verticalis only by its smaller number of raptorial setae; five laterals and four mentals, each side; in this, approaching Enallagma, as already mentioned. Another specimen not bred but apparently of this species, has the gills as slender as in Anomalagrion [pl.15, *e*], an interrupted line of blackish dashes along the axis; a spot before the middle followed by a blackish crescent band.

ANOMALAGRION

There is a single species.

Anomalagrion hastatum Say

Plate 18, fig. 6, 7

1838 Agrion hastatum Say, Acad. Nat. Sci. Phila. Jour. 8:38
1857 Agrion hastatum Selys, Sagra's Hist. Cuban Ins. p.469
1876 Anomalagrion hastatum Selys, Acad. Belg. Bul. (2) 41:255
1893 Anomalagrion hastatum Calvert, Am. Ent. Soc. Trans. 20:240
1895 Anomalagrion hastatum Calvert, N. Y. Ent. Soc. Jour. 3:44 (listed from Keeseville and New York city)
1898 Anomalagrion hastatum Davis, N. Y. Ent. Soc. Jour. 6:196 (listed from Staten Island)
1899 Anomalagrion hastatum Kellicott, Odon. Ohio, p.49
1900 Anomalagrion hastatum Williamson, Dragon Flies Ind. p.279

This exceedingly delicate species is widely distributed in North America, but everywhere very local. I have found it in two places only, in very restricted areas of a few square meters each. In both there was a dense growth of small club-rushes, with cool spring water filtering through them. Among the club-rush stems the linear yellow bodies of these insects are very inconspicuous. They do not appear to fly above or to depart from their native rush patches.

I bred the species at Galesburg Ill. in June 1896, and Prof. C. F. Baker bred it at Auburn Ala. May 15, 1897, and sent me a male imago with its cast skin.

Nymph. Measures in length 8mm, gills barely 4mm additional; width of head 2.3mm.

Color greenish or blackish brown, paler on the legs, on the distal two thirds of the antennae, and on the sutures. Clearly marked specimens show on the pale upper surface of the head a narrow line of brown each side extending from the eye almost to the median line parallel to the hind margin; in front of which a broader and less well defined band extends between the eyes on top of the head. From the head there extends posteriorly to the end of the abdomen a dorsal, indistinct median band, divided by a very narrow median line. There are interrupted lines of black on the carinae of the femora and tibiae, very narrow. Gills [pl.15, *e*] pale with interrupted pigmentation, tending to form diffuse blotches, the most prominent of which is just before the middle of the gill.

Body slender. Head compact, with eyes prominent, obtusely rounded, scurfy, hairy hind angles, and deeply and roundly excavate on hind margin. Legs slender. Wings reaching the base of the fourth abdominal segment. Abdomen a little longer than the gills. Gills lanceolate, long pointed, nearly bilaterally symmetric, widest just beyond the middle.

Antennae seven jointed, the relative length of the joints being as follows in order from the base: 1:1.3:2:1.3:1.5:1.4:1.2:1. Labium of moderate length, mentum not strongly contracted at base, median lobe prominent, fringed with microscopic scales so arranged as to give a serrate edge, mental setae four and often a small rudiment of a fifth, lateral setae [pl.14, *j*] five, movable hook short, arcuate, end hook blunt, and above it on the end of the lateral lobe, three well defined teeth, and above them a denticulate angular prominence.

APPENDIX ON ODONATA

During the past season there has been opportunity for making some further observations on the Odonata-Anisoptera; and in the lapse of time since Bulletin 47 was issued collections have been received from a number of friends, and among the specimens received are a number of nymphs of species belonging to the New York fauna. It is now possible to add descriptions of the nymphs of 11 additional species, with new data on some of the others, together with a few corrections. Dr P. P. Calvert has generously offered for publication here additional data on the distribution of the New York species of Odonata, accumulated since the publication of the second instalment of his list. In bringing such data together in one place, he shows commendable regard for the convenience of the student of our local fauna.

1 ANISOPTERA

ADDITIONAL NOTES WITH DESCRIPTIONS OF HITHERTO UNKNOWN NYMPHS

Hagenius brevistylus, Lanthus parvulus and Dromogomphus spinosus

A number of cast nymph skins of each of these species were found on the stone embankment at the outlet of Forest lake (Fall creek, Ithaca) on my arrival in the latter part of June. A female imago of L. parvulus was found in a mass of foam floating on the water at the foot of a little fall in Fall creek July 9.

Gomphus fraternus

The species to which I have several times referred by this name in print[1] as coming from Havana Ill. was so determined for the Illinois State Laboratory of Natural History by Dr Hagen from material obtained from that locality. It appears from a recent study of this and closely related species by Dr P. P. Calvert[2] that Dr Hagen made a mistake in naming it so. The Havana species is G. externus, and, as may be inferred from the fact that Dr Hagen confused the two species, they are exceedingly closely related. I was unable to use Dr Calvert's paper in the preparation of Bulletin 47, and the description I have given therein on p.451 is drawn from specimens of G. externus. It will apply equally well to the nymph of G. fraternus. I took the latter species in transformation at Ottawa Ill. on May 24, and have since had bred specimens for study from the United States National Museum, collected at Detroit Mich. It has re-

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[1] Canadian Ent. 29:164, 165, pl.7, fig.11 and 12. N. Y. State Mus. Bul. 47, p.451, pl.20, fig.11 and 12.

[2] On Gomphus fraternus, externus and crassus (Order Odonata), Ent. News. 12:65–73, pl.3.

quired an unusually careful examination of the nymphs of the two species to detect any differences whatever. I find only the following, and am not assured as to how constant these will prove. (1) The front border of the median lobe of the labium in externus is slightly but distinctly convex [*see* Bul. 47, pl. 20, fig.12]; in fraternus it is straight or scarcely convex. This is probably a good character. (2) The lateral spines of the ninth abdominal segment are something more than two times the length of the tenth segment in externus; in fraternus they are something less than two times the length of the tenth segment.

Gomphus borealis

I now regard this as a species, and not a variety of G. descriptus. I described it as a variety because I was unable to give any satisfactory character for the separation of females; but a more careful examination of my specimens reveals differences in the form of the hind margin of the occiput, that appear to be reliable. In the female of borealis the occipital margin viewed from the front exhibits two low, rounded lobes, between which is a depression whose curvature is exactly the reverse of the convexity of the lobes. In the female of descriptus the occipital margin is scarcely bilobed, and the median half of it is straight, not concave in the center at least. Comparing the nymphs again, descriptus nymphs from Ithaca with borealis nymphs from Saranac Inn, I find that the lateral spines of the sixth abdominal segment in borealis are half as long as those of the seventh segment; in descriptus, about equal in length on these segments.

GOMPHURUS

This subgeneric name I have used as a convenient designation for the dilatatus group of Selys. Mr Williamson has included some of its species in Stylurus[1], but I prefer as yet to restrict that name to the very homogeneous group of species whose separateness was indicated by Hagen in the *Transactions*

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[1] Amer. Ent. Soc. Trans. 27:205-17.

of the American Entomological Society, 12:269, and for which the name was afterward proposed. Since I have merely applied a name to one of Selys's groups of species, I regard G. dilatatus as the type of Gomphurus, fixed by Selys's usage. I have received from Mr. R. Weith, of Elkhart Ind., a cast skin that can belong to none other than this huge species. I give a description herewith.

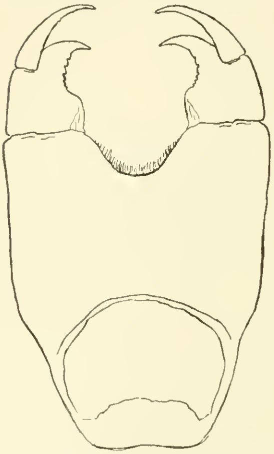

Fig. 14 Labium of the nymph of Gomphus dilatatus

Nymph. Length 38mm, abdomen 22mm, hind femur 7mm; width of head 6.2mm, of abdomen 10mm. Body strongly depressed, with wide abdomen; skin granulate, but little hairy except on the sides of the head, antennae and tibiae; antenna with its third segment thrice as long as the two first segments together; labium rather small; median lobe in front with a deep semicircular concavity, the sides of which are thinly fringed with flattened hairs or scales; lateral lobes strongly hooked on the outer end, and with about six low, irregular, obliquely truncated teeth on the basal two thirds of the concave inner margin; burrowing hooks of the fore and middle tibiae very large, triangular, as long as the greatest diameter of the tibia; dorsal hooks of the abdominal segments very rudimentary, on segments 7–9 only, becoming better defined on these segments successively; lateral spines on segments 6–9, strong, increasing in size posteriorly, those of the ninth segment twice as long as the tenth segment; superior and lateral appendages paler dorsally, the laterals one fourth shorter than the superior.

Gomphus spicatus

The nymph which I described as belonging to this species in Bulletin 47, page 459 does not belong to it. To what it may belong I am quite uncertain; perhaps, to G. furcifer; perhaps to some as yet unknown species. The description of the true G. spicatus nymph will be found in the Illinois State Laboratory of Natural History bulletin, 1901, 6:76.

Gomphus furcifer

Mr T. H. Hankinson took a specimen of this species on the Renwick flats at Ithaca in July 1901, thus establishing the fact that the species belongs to the Ithaca fauna.

Gomphus notatus

This species and G. plagiatus are very closely related. Both are likely to be found in the State eventually. I have recently had bred specimens of notatus for study from the United States National Museum, and from Mr E. B. Williamson, the former from Detroit Mich. and the latter from Nashville Tenn. The differences between the nymphs of the two species are so slight that they will be appreciated with difficulty by a novice. They are as follows: (1) In notatus the ninth abdominal segment is more than five times as long as the tenth segment; in plagiatus, less than five times as long. (2) The two to three obliquely truncated teeth on the inner margin of the lateral lobe of the labium are twice as big in notatus as in plagiatus [*see* Bul. 47, pl.20, fig.16]. (3) The rudiment of a dorsal hook on the apex of the ninth abdominal segment is a little better defined in notatus.

Gomphus spiniceps

A nymph of this species was taken from Forest lake, Ithaca, by Mr O. A. Johannsen, in July 1902, and reared.

Gomphus descriptus

Corrections. In Bulletin 47, page 454, there are stated to be six to eight teeth on the inner margin of the lateral lobe of the labium of the nymph of this species; the number should be eight to ten as given in the key on page 446.

On page 436 the word "tarsi" in line *aa* in the key at the bottom of the page should read "femora."

CORDULEGASTERINAE

Cordulegaster sayi

I have received nymphs from Mr C. S. Brimley of Raleigh N. C. that should belong to this species, because of their locality and their very close resemblance to those of C. diastatops.

Nymph. Length 34mm, abdomen 24–25mm, hind femur 4.5mm; width of head 7.5mm, of abdomen 8mm.

Head broad, concave between the eyes, and with a prominent rounded frontal shelf, whose border is fringed with stiff hairs; eyes capping the anterolateral angles of the head; sides of the head bulging behind the eyes, and regularly rounded to the slightly concave middle hind margin, scurfy hairy; thorax and bases of the legs very hairy; disk of the prothoracic dorsum produced laterally at its ends into thin, shelflike, bristle-fringed lobes.

Face blackish; sides of the mesothorax and metathorax brown, divided by a broad, vertical paler stripe (an indication of the adult color pattern, that is apt to be absent in younger nymphs); wing cases with darker pigmentation on the nodus and at the stigma; abdomen with a pale, middorsal line, bordered at either side with a row of large, brown spots, a pair on each segment, best defined on segments 7 and 8 and largest on segment 8. Between these rows and the lateral margins on each side are two additional equidistant rows of ill defined spots, and the apical angles of each segment are washed with brown. Abdomen little hairy beyond the middle, much less so than in diastatops; stout, straight, conspicuous lateral spines on segments 8 and 9; appendages yellow, black tipped and with a copious fringe of black hairs on their internal margins.

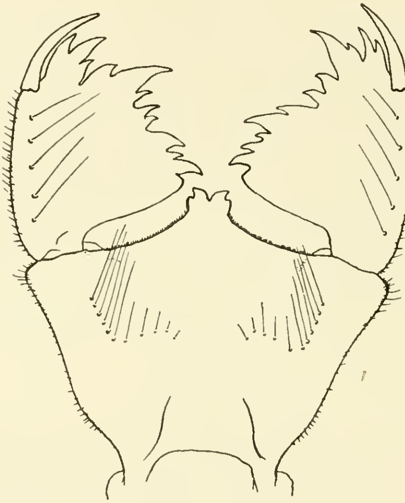

Fig. 15 Labium of the nymph of Cordulegaster sayi (supposition)

Labium [fig.15] of the usual large size and spoon-shaped form, with five lateral setae and 11 mentals each side, the six outermost of the mentals in a stronger series. Median labial lobe fringed except in the middle, where there is the usual bifid median tooth, each half of which in this species and in diastatops is again bifid; but in this species it is about equally bifid, i. e. the two lobes thus formed are about equal in size, while in diastatops the lower lobe is much smaller, scarcely rising above the level of the fringe.

CORDULIINAE

SOMATOCHLORA

Since Bulletin 47 was written, I have obtained nymphs of two additional species of Somatochlora; and, while neither of them is bred, I deem it worth while to describe them now, in order that the new characters they present may allow a better defining of the genus. The characters which I stated with due caution in the table of nymphs (*loc. cit.* p. 485) now need amplification in but one minor particular: the dorsal hooks, while not cultriform, may be, as in these two species, sharply pointed.

Somatochlora sp.? no. 2

Length 24mm, abdomen 15mm, hind femur 8mm, antenna 6mm; width of head 6.2mm, of abdomen 8mm.

Body stout, moderately depressed, very hairy on the antennae, sides of head and thorax, legs and base of abdomen; head wider than long, eyes small, capping the anterolateral angles; head narrowed behind the eyes to the broadly concave hind margin; legs slender, with faint, subapical rings of brown on the femora; wing cases reaching the base of the sixth abdominal segment; abdomen triquetral, widest on segment 6, slightly narrowed on 7, more narrowed on 8, strongly narrowed on 9, in so much that segment 10 is less than half as wide as 9 at base; segment 10 very short, annular, included in the dorsally emarginate apex of 9; appendages as long as segments 9 and 10 together, the inferiors slightly longest and the superior a very little longer than the laterals; lateral spines on segments 8 and 9 equal in length to one third or one fourth of the length of their respective segments, those of the ninth hardly longer than those of the eighth segment; dorsal hooks on segments 4–9 similar, but stouter on segments 7–8, and spinulose on their very convex, superior margins on 6–9 (their inferior margin viewed laterally).

Labium with seven lateral setae and 11–12 mental setae, each side of which the fifth (counting from the side) is longest, and the outermost 7–8 constitute a stronger series. Teeth on the opposed margins of the lateral lobes inrolled, moderately well marked, each about 4 spinulose.

On the middle of the sides of the abdomen are two longitudinal brownish bands, below which the sides are paler.

One specimen, collected by Mr T. H. Hankinson near Varna, 2 miles above Ithaca, from a cold spring brook near to the place of its confluence with Fall creek, July 13, 1901. I collected a specimen of the same species in Six Mile creek a mile southeast of Ithaca in April 1896. I innocently placed it in a breeding cage in which were a few Gomphus nymphs burrowing in the mud of the bottom; for I did not then know that Gomphus nymphs go foraging in the territory above them. The next morning there remained in my cage but a fragment of the Somatochlora nymph, consisting of the dorsal wall of the abdomen and the abdominal appendages. This fragment I preserved, for I had recognized that the nymph was a new one, and I find it quite sufficient for recognition as the same species described above. The dorsal hooks are perhaps twice as long in this species as in S. elongata. Since S. elongata is the only species known from Ithaca, I am unable to say to what species this nymph may belong.

Somatochlora sp. no. 3

A single nymph, not fully grown, sent me from Raleigh N. C. by Mr C. S. Brimley. It is a short, flat species with very wide, abruptly truncated abdomen. Somatochlora tenebrosa has been collected at Raleigh, and the nymph may belong to that species.

Length 16mm, abdomen 9mm, hind femur 5.5mm, antenna 6mm; width of head 5mm, of abdomen 8mm. In form and ornamentation of the head and front part of the body and in armature of the labium similar to the preceding species. Differs in the relatively greater width and flatness of the abdomen, in having the lateral spines of segments 8 and 9 wider, flatter, blunter and straighter at tip, and triangular in outline as seen from above; appendages shorter and more retracted, the tip of the laterals hardly surpassing the level of the tips of the lateral spines of the ninth segment (surpassing these by half their length in the preceding species). Dorsal hooks shorter, on segment 4 a mere rudiment, on 5 small, on 6–9 better developed, spinulose on superior and straight and bare on inferior margins.

LIBELLULINAE

Sympetrum corruptum Hagen

Prof. T. D. A. Cockerell took this species in transformation at Tempe Ariz. on Salt river Mar. 30, 1902, and kindly sent me specimens which he has allowed me to describe herewith. He sent me also a single male with its cast nymphal skin labeled Las Vegas N. M., October 1901. Thus we have the life history of this species from the western end of its range, and, though coming from an unexpected quarter, it makes a very desirable addition to our knowledge of the fauna of the State. In New York State this species flies only in late summer and autumn (in early spring I have twice found a specimen that, I suppose, had hibernated); but in the southwest it flies throughout the greater part of the season.

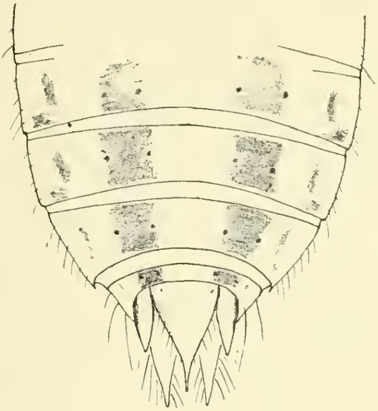

Fig. 16 End of abdomen of nymph of Sympetrum corruptum

Nymph. Length 19mm, abdomen 11mm, hind femur 4.5mm; width of head 4.5mm, of abdomen 6mm. Body stout, little depressed, sparsely hairy on the rear of the head, the outer margins of the tibiae and the apex of the abdomen. Head much wider than long, with prominent eyes directed forward and almost angulate anterolaterally; sides sloping behind the eyes to the nearly straight hind margin, and scurfy hairy; top of head with six longitudinal, scurfy hairy lines behind the transverse suture.

Dorsum of the thorax fuscous, divided by a narrow longitudinal, pale line; the sides with some ill defined fuscous markings; legs pale.

Abdomen with a pair of broad, dorsal fuscous stripes interrupted on the sutures, extending posteriorly to end at the bases of the lateral appendages on each side, including a pair of transversely placed darker spots [fig.16]. On each side, half way from this band to the lateral margin, there are on each segment a pair of brownish marks, of which the lower one is transversely placed and rests on the apical carina of the segment; each lateral appendage is black on its lateral margins.

No dorsal hooks at all. Lateral spines almost wanting, represented only on the ninth segment by a very minute tooth, which continues the inward slope of the lateral margin. Sides of abdomen nearly parallel on segments 4-7, slightly narrowed posteriorly on 8, strongly narrowed on 9; 10 annular, included, one fourth to one third as long as 9; superior appendages as long as segments 9 and 10 together, lateral appendages fully one third shorter than the others; the lateral and ventral margins of segments 9 and 10 very hairy.

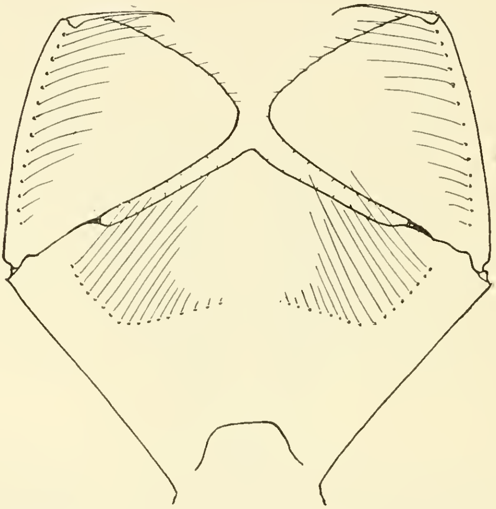

Fig. 17 Labium of Sympetrum corruptum

This species differs from its nearest relative, S. illotum, (1) in having 13-14 lateral setae on its labium [*see* fig.17], in S. illotum there are but 9; (2) in having about 17 mental setae, each side of which there are nine in the stronger outer series—in illotum there are about 13, and seven in the stronger outer rank; (3) in having the lateral spines even less developed; (4) in having a better developed color pattern. Except in these particulars the nymph of S. illotum (of which

I have a number of specimens kindly communicated by Prof. V. L. Kellogg, of Stanford University) is very similar. In both these species the labial hinge reaches posteriorly between the bases of the middle legs.

These two southwestern species are at least subgenerically distinct from our eastern species; but a study of the not very homogeneous palearctic species should precede any attempt at the division of the genus.

LIBELLULA

Of the nine species of this genus which I listed from New York State in Bulletin 47, the nymphs of four were unknown. I believe I have the nymphs of two of these, though neither has been bred, and I describe them below.

Libellula axillena (supposition)

A single nymph not fully grown, from Raleigh N. C., collected by Mr C. S. Brimley.

Length 22mm, abdomen 14mm, hind femur 5mm; width of head 5mm, of abdomen 7.2mm. Very similar to the nymph of L. auripennis; having sharp pointed dorsal hooks on abdominal segments 4-8 and five setae on the lateral lobe of the labium, it would be traced to that species by my key (loc. cit. p.532); but it differs in the following particulars. (1) The mental setae are 12-13 each side, the six to seven outermost larger and closer together than the others. (2) The lateral spines of the eighth and ninth abdominal segments are less distinctly incurvate at tip and bear finer bristles on their external margin. (3) The lateral abdominal appendages (white with black margins) are but a third as long as the inferiors (they are one half as long in auripennis). There is also in this nymph a black band across the head between the eyes; there are subapical bands on the femora.

Libellula cyanea

I have received numerous specimens of this nymph from Newark and Cooch Del., sent by Prof. E. D. Sanderson, and from Raleigh N. C., sent by Mr C. S. Brimley. These nymphs all show (what I did not see in the cast skins I described) a submedian, ventral double row of round, small, brown dots; there is a corresponding double dorsal row of plainer dots ending opposite the lateral appendages, and between the two lines of dots on the dorsal side is a double row of broader, obscurer brownish marks close beside the middle pale line. The number of lateral setae appears to be somewhat variable: while six is the normal number, seven occur sometimes; but the species is in such cases distinguishable from basalis by the brown markings just described.

Libellula plumbea (supposition)

I have a single specimen of this species, received from Mr C. S. Brimley of Raleigh N. C. It is very similar to the nymph of L. cyanea, but is at once distinguished by the possession of eight lateral setae on the labium.

Length 17mm, abdomen 10mm, hind femur 5mm; width of head 5mm, of abdomen 7mm (not fully grown). Head with an anvil-shaped black mark on either side of the median ocellus; a pale median line extends from the median suture of the head to the base of the abdomen; segments 2-8 of abdomen each with a pair of large, oblique, brown spots on the sides, becoming diffuse on 7 and 8 and the apical portion of each becoming detached as a darker, small, round dot; there is also an outer row of dots blacker on segments 4-9; femora and tibiae faintly twice banded. There are four lines of pubescence each side down the back of the head.

Lateral setae of labium 8, mentals 12-13, each side of which the outer seven are in a larger series. Dorsal hooks of abdomen on segments 4-8, spinelike on 6-8, and straight on the superior margin differing in this from nymphs of basalis, in which the apexes are declined and the upper margin arcuate). The superior appendage is longer and more contracted in the middle and more attenuate to the apex than in basalis.

I conclude my part of this appendix with a tabular statement of the general features of the habitat of such New York species as I have had good opportunity for observing in the field. Further observation will probably discover that some of these have a wider range of habitat; but I trust that this table contains hints that will be of use to the amateur collector. My record for brackish water species is based on a small collection from Sable island sent me by Dr James Fletcher. There is no fresh water there; and the material sent included cast nymphal skins of the two species listed here, taken on the spot.

Habitat of some New York Odonata

SPECIES OBSERVED	RAPID STREAMS							MARSHES		
	Rapids	Beds	Edges of current	Slow streams	Rivulets	Lakes	Ponds	Springy	Stagnant	Brackish
P. obscurus	x	x	....	....	....	....	....	....	....	....
O. aspersus	x	x	....	....	....	....	....	....	....	....
O. carolus	x	x	....	....	....	....	....	....	....	....
H. brevistylus	....	x	....	....	....	....	....	....	....	....
L. parvulus	....	x	....	....	....	....	....	....	....	....
G. abbreviatus	....	x	....	....	....	....	....	....	....	....
G. brevis	....	x	....	....	....	....	....	....	....	....
G. fraternus	....	....	....	x	....	....	....	....	....	....
G. descriptus	....	x	....	....	....	....	....	....	....	....
G. sordidus	....	x	....	....	....	....	....	....	....	....
G. exilis	....	x	....	x	....	x	x	....	....	....
G. scudderi	....	x	....	....	....	....	....	....	....	....
G. plagiatus	....	....	....	....	....	x	....	....	....	....
G. spiniceps	....	x	....	....	....	....	....	....	....	....
G. spicatus	....	x	....	x	....	....	x	....	....	....
G. villosipes	....	x	....	x	....	....	....	....	....	....
D. spinosus	....	....	....	....	....	x	....	....	....	....
B. vinosa	....	....	x	x	....	x	....	....	....	....
B. janata	....	....	x	....	....	....	....	....	....	....
N. pentacantha	....	....	x	....	....	....	....	....	....	....
A. constricta	....	....	....	x	....	x	x	....	....	....
A. junius	....	...	....	x	....	x	x	....	x	x
C. maculatus	....	x	....	....	....	....	....	....	....	....
C. diastatops	....	....	....	....	?	....	....	x	....	....
D. transversa	....	x	....	x	....	....	....	....	....	....
E. princeps	....	....	....	x	....	x	x	....	....	....
T. spinigera, cynosura	....	....	....	x	....	x	x	....	....	....
H. uhleri	....	....	....	....	....	....	....	x	....	....
S. elongata	....	....	....	....	....	x	x	....	....	....
D. libera	....	....	....	....	....	....	x	....	....	....
N. bella	....	....	....	....	....	....	....	....	x	....
P. domitia	....	....	....	....	....	....	x	....	x	....
C. eponina	....	....	....	x	....	x	x	....	....	....
C. elisa	....	....	....	....	....	x	x	....	....	....
L. intacta, glacialis	....	....	....	....	....	....	x	....	x	....
S. corruptum, rubicundulum, etc.	....	....	....	....	....	....	x	....	x	....
P. longipennis	....	....	....	....	....	....	x	....	x	....
M. simplicicollis	....	....	....	....	....	....	x	....	x	....
L. julia	....	....	....	....	....	x	x	....	....	....
L. basalis, pulchella	....	....	....	x	....	x	x	....	....	....
P. lydia	....	....	....	x	....	x	x	....	....	....
T. lacerata	....	....	....	....	....	x	x	....	....	....
P. flavescens	....	....	....	....	....	x	x	....	....	....
H. americana	x	....	x	....	....	....	....	....	....	....
C. maculata	x	....	x	x	....	....	....	....	....	....
L. eurina, uncata, forcipata, etc.	....	....	....	....	....	....	x	x	x	....
A. putrida	x	....	x	....	....	....	....	....	....	....
A. apicalis	....	....	....	x	....	....	x	....	....	....
A. violacea	....	....	....	x	....	....	....	....	x	....
C. conditum	....	....	....	....	....	x	x	x	....	....
A. saucium	....	....	....	....	x	....	....	....	....	....
N. irene	....	....	....	....	....	....	x	....	x	....
E. hageni, signatum etc.	....	....	....	x	....	x	x	....	x	....
I. verticalis	....	....	....	x	x	x	x	x	x	x
A. hastatum	....	....	....	....	....	....	....	x	....	....

It certainly is not without interest one observes in glancing over this table that while the majority of the species live in ponds or still water, the more generalized members of both suborders live in rapids of streams.

The species of which nymphs are newly characterized in this appendix are[1]:

Gomphus fraternus*
Gomphus borealis
Gomphus dilatatus
Gomphus notatus*
Cordulegaster sayi
Somatochlora, sp. no. 2
Somatochlora, sp. no. 3
Sympetrum corruptum*
Sympetrum illotum*
Libellula axillena
Libellula plumbea

Distribution of New York dragon flies

ADDITIONAL DATA[2]

By Dr P. P. Calvert

Lestes vigilax. Folwood lake, July 22; Knapp pond, July 30; Stevensville lake, Aug. 1; Amber lake, Aug. 2; Black lake, Aug. 2; Beaver brook, Aug. 3; Stump pond, Aug. 3; Green lake, Aug. 28; Catskill lake, Aug. 30.

Lestes disjuncta. Hunter's pond, July 30; Mud pond, July 30; Beaver brook, Aug. 3; Burnt Hill pond, July 29; Catskill lake, Aug. 30 (abundant).

Lestes rectangularis. Black lake, Aug. 2; Beaver brook, Aug. 3; Stump pond, Aug. 3; Cairo, Aug. 29; Stony Clove near Hunter, Sep. 2.

Argia violacea. Jenkins' pond, July 29; Amber and White lakes, Aug. 2; Black lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Green lake, Aug. 28 (very abundant).

Argia translata. White lake, Aug. 2.

Amphiagrion saucium. Big pond, July 28 (with pruinose thorax, abdomen still red).

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[1] Those marked with an * are bred.

[2] Supplemental to the two lists by the same author referred to in the preceding pages, in N. Y. Ent. Soc. Jour. 1895, 3:39-48; and 1897, 5:91-96.

Ischnura verticalis. Folwood lake, July 22; Balsam lake, July 27; Alder lake, July 28; Big pond, July 28; Jenkins' and Burnt Hill ponds, July 29; Knapp, Hunter's and Mud ponds, July 30; Cranberry pond, July 31; Stevensville lake, Aug. 1; Amber, White and Black lakes, Aug. 2; Beaver brook and Stump pond, Aug. 3; Green lake, Aug. 28; Cairo, Aug. 29; Catskill lake, Aug. 30.

Enallagma hageni. Knapp pond, July 30 (not very abundant).

Enallagma aspersum. Burnt Hill pond, July 29; Knapp pond, July 30; Cranberry pond, July 31.

Enallagma exsulans. Port Jervis, July 21.

Enallagma geminatum. Amber lake, Aug. 2; Green lake, Aug. 28.

Enallagma ebrium. Balsam lake, July 27; Alder lake, July 28 (exceedingly abundant, many more males than females); Burnt Hill pond, July 29; Cranberry pond, July 31; Amber, White and Black lakes, Aug. 2; Beaver brook, Aug. 3; Catskill lake, Aug. 30.

Enallagma signatum. Folwood lake, July 22; Amber and Black lakes, Aug. 2; Stump pond, Aug. 3; Green lake, Aug. 28.

Enallagma pollutum. Black lake, Aug. 2.

Dromogomphus spinosus. White lake, Aug. 2.

Anax junius. Folwood lake, July 22; Alder lake, July 28; Burnt Hill pond, July 29 (abundant); Knapp, Hunter's and Mud ponds, July 30; Cranberry pond, July 31; Black lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Green lake, Aug. 28.

Cordulia shurtleffi. Near Tunis lake, July 27.

Dorocordulia lepida. Burnt Hill pond, July 29; Mud pond, July 30; Amber lake, Aug. 2.

Libellula pulchella. Folwood lake, July 22; Balsam lake, July 27; Alder lake and Big pond, July 28; Jenkins' and Burnt Hill ponds, July 29; Knapp and Hunter's ponds, July 30; Cranberry pond, July 31; Amber lake, Aug. 2 (only a few); Black lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Cairo, Aug. 29 (1 old ♂).

Libellula incesta. Amber lake, Aug. 2; Stump pond, Aug. 3.

Plathemis lydia (trimaculata). Beaver brook, Aug 3 (1 ♂ only); Cairo, Aug. 29 (1 old ♂).

Leucorhinia frigida. Knapp, Hunter's and Mud ponds, July 30; Cranberry pond, July 31 (abundant).

Leucorhinia intacta. Folwood lake, July 22 (1 ♀).

Celithemis elisa. Burnt Hill pond, July 29 (one only); Hunter's pond, July 30 (one only); Cranberry pond, July 31 (one only); Amber and White lakes, Aug. 2 (some in cop.).

Sympetrum rubicundulum. Folwood lake, July 22; Jenkins' pond, July 29; Knapp, Hunter's and Mud ponds, July 30; Black lake, Aug. 2; Stump pond, Aug. 3; Cairo, Aug. 29.

Sympetrum vicinum. Alder lake, July 28; Burnt Hill pond, July 29; Stevensville lake, Aug. 1 (just transforming); Amber lake, Aug. 2; Beaver brook and Stump pond, Aug. 3; Cairo, Aug. 29; Catskill lake, Aug. 30 (some transforming, others ovipositing).

Sympetrum semicinctum. Cairo, Aug. 29.

Aeschna constricta. Stony Clove, near Hunter, Sep. 2.

Localities

Records from Cairo, Catskill lake and Green lake were made in 1897. All others in 1898.

Big pond,	Andes	“ town ” (=township),	Delaware co.
Balsam lake,	Hardenburg	“	Ulster co.
Tunis “	“	“	“
Alder “	“	“	“
Jenkins' pond,	Rockland	“	Sullivan co.
Burnt Hill “	“	“	“
Knapp “	“	“	“
Hunter's “	“	“	“
Mud “	Liberty	“	“
Cranberry “	“	“	“
Stevensville lake,	“	“	“
White “	Bethel	“	“
Amber “	“	“	“
Black “	“	“	“
Folwood “	Mamakating	“	“
Beaver brook,	Tusten	“	“
Stump pond,	“	“	“
Green lake,	Athens	“	Greene co.
Cairo,	Cairo	“	“
Catskill lake,	Hunter	“	“

Eastern Long Island species

COLLECTED AUG. 18, 1900

Lestes disjuncta. Bridgehampton
Enallagma doubledayi. Bridgehampton
Enallagma aspersum. Bridgehampton
Enallagma durum. Near Mecox bay (abundant; in cop.)
Enallagma civile. Near Mecox bay (abundant; in cop.)
Ischnura verticalis. Near Mecox bay and Bridgehampton
Anax junius. Near Mecox bay and Bridgehampton
Plathemis lydia (trimaculata). Bridgehampton
Libellula pulchella. Bridgehampton
Tramea carolina. Bridgehampton
Mesothemis simplicicollis. Bridgehampton

Near Mecox bay, where I found the two species of Enallagma above recorded were many individuals of the spider, Epeira stellata Hentz, whose orblike webs, 4 to 6 inches in diameter, were stretched between the stalks of sedges and of grasses. Within a distance of not more than $\frac{1}{10}$ mile along the pond's edge, I found six individuals of Enallagma in the spiders' webs. The dragon flies were all fully colored, were more or less enshrouded in silk, and some of them were partly eaten. In one and the same web were two Enallagmas.

Part 4

SOME NEW LIFE HISTORIES OF DIPTERA

BY JAMES G. NEEDHAM

During the second season of our station the work done on Diptera was chiefly done on the families Chironomidae, Culicidae, Simuliidae, and Blepharoceridae, and is reported on by Mr Johannsen in part 6. But, in the course of routine operations, a few other very interesting new forms were come on, and four of these will be described in the following pages. Two of these, Tipula flavicans and Epiphragma fascipennis, were bred, and two were found only in the larval stage. These larvae, however, are so unique and interesting as to warrant their description at once; one clearly belongs to the family Tipulidae; the other to the family Leptidae.

Tipula flavicans Fabricius

1805 Tipula flavescens (*in erratis*, flavicans) Fabricius, Syst. Antliatorum, p.24

1821 Tipula flavicans Wiedemann, Diptera Exotica. 1:25

1828 Tipula flavicans Wiedemann, Aussereur. zweiflüg. Insecten, 1:48

1878 Tipula flavicans Osten Sacken, Cat. Dipt. N. Am. p.38 (listed)

This common crane fly is widely distributed over the eastern United States and Canada. It belongs to the New York fauna, but I bred it from pupae collected at Lake Forest Ill. The pupae were found in a peculiar and very restricted habitat. In the bottom of a glacial pothole on the top of a small moraine there was a deep bottom layer of mud, muck and humus, nearly dry from the summer's evaporation, and perforated by a few crawfish holes, around whose mouths were little hillocks of clay, brought up by the crawfishes from a deeper stratum. In these clay hillocks, and only in these, I found the pupae, placed vertically in cylindric cavities, their heads almost reaching the upper surface of the clay. I collected a number of the pupae on Sep. 22, and the imagos began to emerge on the 23d and were all out on the 27th. During this time the adult flies were common among the bushes all about the pothole. They were not so easy to catch as are most crane flies; they readily took flight on the approach of a net, and, if pursued, would take refuge high up in the branches of neighboring trees, well out of reach.

Pupa [pl.10, fig.3]. Length 26mm, abdomen 20mm, respiratory horns 1.3mm; greatest diameter of the thorax 4mm, of abdomen 3mm.

Body cylindric, tapering at ends on the head and from the eighth abdominal segment, the abdomen with parallel sides, the thorax thickened toward its middle. Colors (generally obscured by adherent dirt) brown, paler on wings and legs, on lateral margins of abdomen and on two broad dorsal and two ventral areas nearly covering each abdominal segment.

Head unarmed; rostral sheath and base of antennal sheaths transversely corrugated. Antennae curving posteriorly around the eyes and ending at the middle of the thorax on its ventral side. Palpi ending in a J-shaped hook.

Respiratory horns cylindric, becoming laterally flattened at tip, erect but bent anteriorly in their distal third. Wings and legs closely covering the ventral surface; tips of the wing cases reaching the base of the fourth abdominal segment; legs much curved beneath the wing cases; tarsi laid straight along the ventral side of the abdomen, those of the fore legs reaching the constriction of the middle of the fourth, those of the middle and hind legs, the apical circlet of spines on the fourth abdominal segment. Thorax unarmed; a low carina between the respiratory horns, ending posteriorly in a series of transverse corrugations, on either side of which are spots and lines of darker color.

Abdominal segments transversely divided by a constriction, both before and behind which, dorsally and ventrally, is a broad pale area bordered by darker brown, forming at the sides a band which includes the row of spiracles at the anterior border of segments 1-7. In the pale band on the lateral margin there arises a stout spine in the basal half and a larger one in the apical half of segments 2-7; here are also numerous brown dashes, merging into the larger, phalerate markings already described.

On the dorsal side in the apical half of each of segments 1-7 there is a transverse row of about a dozen sharp, minute thorns, very minute on 2, but becoming larger posteriorly; on the ventral side of same is a similar row of stouter thorns, becoming much stouter and fewer and nearer the hind margin posteriorly, while before them, near the middle constriction, stand an isolated pair of similar size. On segment 8 there are three pairs of stout spines on the dorsum, the intermediate pair being the largest, and there are three lesser pairs on the venter. On the end of the abdomen, and perhaps belonging to a ninth segment, there are two other pairs of spines, a larger yellowish, brown tipped, straight pair, and a smaller, terminal, upcurved pair.

Epiphragma fascipennis Say

Plates 8, 9

Limnobia fascipennis Say, Acad. Nat. Sci. Phila. Proc. 3:19, 11:823

1828 Limnobia fascipennis Wiedemann, Aussereur. zweiflüg. Insecten, 1:31

1859 Epiphragma pavonina Osten Sacken, Acad. Nat. Sci. Phila. Proc. p.239

1869 Epiphragma fascipennis Osten Sacken, Mongr. N. Am. Dipt. 4:194

This beautiful crane fly [pl.8], which Osten Sacken attributes to the Atlantic states and Quebec, I have been trying to rear for several years at my home in Lake Forest; and I succeeded in the spring of 1901, and am now able to describe both larval and pupal stages.

The larvae bore in the dead and fallen stems of buttonbush and willow, where these lie on the mud at the borders of shallow ponds. I found them always in stems that were still partially sound, tunneling beneath the bark or even into the deeper parts and into the sounder wood. These stems are frequently submerged in spring and autumn, and even in summer, when the pond has gone dry, they are always saturated with moisture. The first two seasons that I tried to rear the larvae indoors I failed, because I could not keep their surroundings at the proper degree of moisture. In the spring of 1901 I placed the stems or pieces of the stems containing the larvae in the bottom of a big glass jar, hung a large sponge saturated with water in it, and laid on a loose cover, and with this apparatus I reared them, every one. Larvae and pupae were collected for rearing on May 18; imagos appeared on May 30. No imagos were seen at large, notwithstanding they were carefully looked for several times after they began to appear in the breeding jar.

The most interesting thing about the larva, aside from its wood-boring habits, is its singular adaptation to amphibian life. It must needs live part of the time wholly submerged beneath the waters of the pond, and part of the time out on land; it has, therefore, both open spiracles and tracheal gills; and, moreover, its tracheal gills are so placed that they may be withdrawn into the body in a dry time, where they escape the ills of too rapid evaporation. The spiracles are the two usual large ones on the terminal respiratory disk, common to all tipulidae. If a larva be taken from the stems and allowed to crawl on the hand, these will be the only respiratory apparatus visible; no fleshy anal processes, such as are common in the family, will be seen. The anal aperture will appear as a narrow longitudinal slit between two opercular flaps. But, if the same larva be placed in a watch glass of water, these flaps will be seen to be separated, and there will be protruded between them four curved triangular, delicate, whitish, elongate gills, showing in their interior both tracheae and blood currents. These are doubtless respiratory appendages of the terminal portion of the walls of the rectum. A similar eversible condition of this part, with a much less perfect development of the gills themselves, has recently been described by Pantel in the *Bulletin de la Société entomologique de France*, 1901, page 59-61, for a Tachinid larva. The eversible portion of the rectum Pantel calls the anal vesicle, and to it he very properly attributes a respiratory function.

These four gills in Epiphragma are comparable to the four anal processes of the larva next to be described, and shown on plate 10, fig. 4, even to the constriction forming an apparent segment near the tip. They are comparable and homologous doubtless with the anal processes of other Tipulidae. There, however, they are permanently on the outside of the body, being no longer retractile. The end of the rectum has become permanently everted in these more aquatic larvae. The larva of Epiphragma is therefore specially interesting as showing what has been the course of development of this part of the very curious caudal armature of the typical Tipulid larvae.[1]

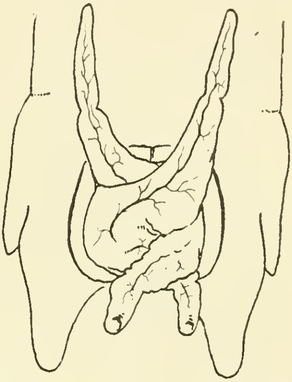

Fig. 18 Anal gills of the larva of Epiphragma fascipennis

Larva [pl.9, fig.1]. Length 19mm; greatest diameter (base of thorax) 1.5mm. Cylindric, white, or faintly tinged with yellowish, with translucent sides and a brown head capsule. Head large, for the family, with pale antennae and labrum and stout blackish mandibles and labium. On the ventral side of each of the three thoracic segments is a pair of minute brownish points—vestiges

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[1] Elsewhere (*American Naturalist*, 36:185) I have pointed out, in a description of the larva of Bibio fraternus, that the segmental tubercles have offered the material out of which have been formed the other fleshy tubercles which surround the caudal respiratory disk.

of the larval legs. On the ventral side of abdominal segments 2-7 there is a single median proleg—a mere soft, white, transversely placed ridge, without hooks or claws. The abdomen is without other tubercles, spines or hairs. On the posterior end of the scarcely narrowed abdomen is a broad, white respiratory disk, with the two usual spiracles [pl.9, fig.2], large, distant, black, bordered with golden yellow in life. There are four thick processes at the border of the disk, of which the upper two are set apart the full width of the disk, have very blunt apexes and are pubescent externally, while the lower two are a little more pointed and a little closer together.

The anal aperture is closed by two operclelike plates, which open to allow the protrusion of the four delicate, white, elongate, curved, triangular anal processes (gills).

Pupa [pl.9, fig.3]. Length 12mm, horns almost 2mm additional; diameter 1.5mm. Color clear yellowish white at first, darkening with age, and showing before transformation the adult color pattern through the transparent skin; surfaces shining, nearly smooth. Head and face directed ventrally, with a pair of short, sharp pointed, stout, ventrally directed, divergent frontal spines.

The hypertrophied and functionless respiratory horns are large, long and stout, abruptly bent forward in their cylindric middle portion, beyond their short erect bases, and convergent at their tapering tips. They are very suggestive of cow horns in their shape, and a crumpled horn on one side is of rather common occurrence. The antennae curve dorsally around the eyes and knees and disappear beneath the wings. Legs laid flat against the ventral surface, the tips of the tarsi all ending near the apex of the fourth abdominal segment; wing tips reaching only to the level of the carina on the second abdominal segment.

Abdomen with sides parallel as far as the eighth segment; the apical carina on each segment is fringed with short, stiff hairs (on the ventral side of the eighth segment, more comblike, and interrupted on the median line in the female). The rudiments of the four discal processes and the atrophied spiracles are plainly seen on the dorsum of the eighth segment.

Beling found the larvae of the European Epiphragma picta abundant in the rotting stems of ash and beech in the spring, transforming in May after a pupal period of about two weeks. He has described[1] a very unusual sexual differentiation in the larvae. The respiratory disk was said to be surrounded by five processes arranged in a pentagon in the male, by three processes arranged in a triangle in the female larva. There is no such differentiation in E. fascipennis; the processes are four, and alike in the two sexes. Possibly Beling had the larvae of two species.

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[1] Beling, Th. zur Naturgeschichte verschiedener Arten der Tipuliden. Verh. zool.-bot. Ges. in Wien. 1873. 23:590.

An unknown Tipulid larva from a spring

On plate 10, figures 4 and 5 we present a figure of a Tipulid larva of very unusual form. A few specimens were obtained July 19, 1901, from a small, cold spring brook near Fall creek, between Ithaca and Varna N. Y. The brook was filled with water cress, through which the cold water trickled, and was hidden in the dense shadow of a thick growth of trees. The larvae were obtained only beneath the water cress, in the thin layer of soft mud overlying the rocky substratum. One larva was found, apparently preparing for transformation, occupying a little excavation among the roots of a layer of wet moss, in a crevice of a rock above the level of the water. This specimen was taken home for rearing, but was afterward lost; I do not know anything about the other stages of this insect. The form of its respiratory disk is very different from that of Epiphragma just described, but, aside from that, it is more like Epiphragma in form of body and prolegs and in mouth parts than any other Tipulid larva known to me, and I think it will be found to belong to some species of larger size belonging near Epiphragma in the series.

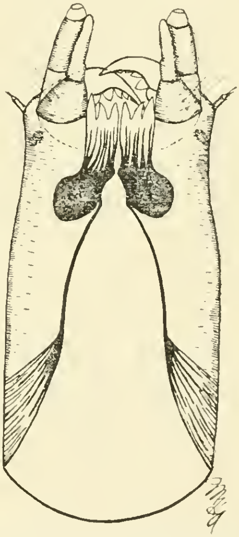

Fig. 19 Ventral aspect of head and mouth parts of unknown tipulid larva described herewith

Since my study of this larva Dr James Fletcher, of Ottawa Can., has sent me a specimen of it from his home. He says it is found "from time to time in water brought from a spring through wooden pipes, and used for drinking." It may prove a constant inhabitant of cold spring water.

Larva. Length 42mm; greatest diameter of thorax 5mm; of abdomen 7mm. Body cylindric, smooth, white translucent, with unusually abrupt narrowing at the anterior end to the wholly retractile head (fig.19). Seventh abdominal segment inflated. No surface hairs or spines; but on the ventral side of the three thoracic segments are three pairs of spine-tipped structures which I take to be the rudiments of the thoracic legs.

There are stout, brownish prolegs on abdominal segments 4-7, paired and separate on 4, becoming completely fused on succeeding segments into a transverse ridge, each proleg capped with a mere obtuse hillock of chitin, bearing no hooks or spines. Abdomen strongly tapering beyond the inflated seventh segment. Spiracles black, seated on a narrow and imperfect respiratory disk [pl.10, fig.5], whose dorsal margin is indicated only by a slight ridge, and from whose ventral side arise two long processes, approximated at base, tapering, slightly granulate before the tip, and with about six to eight minute, fragile, unequal hairs on the obtuse apex. Anal aperture surrounded by four equal, taper, pointed, white appendages, each showing a tendency to the formation of a telescopic joint at two thirds its length.

An unknown Leptid larva from rapid streams

On plate 10, figure 1 we show a curious larva that seems clearly to belong to the family Leptidae, but that differs considerably in structure from the Leptid larvae hitherto made known. I first collected small specimens from the rapids in Six Mile creek at Ithaca in December 1896. During the summer of 1901 larger larvae were frequently found in Fall creek. They live in the crevices of the stones in rushing waters, associated with stone fly and caddis fly larvae. But few specimens were obtained, and no attempt was made to rear them. Two species of Chrysopila, (C. ornata and C. thoracica), are common at Ithaca, and this larva may belong to one of these.

Larva. Length 16mm; caudal filaments (arising from the ventral border of the respiratory disk) 3mm additional; diameter 2mm.

Color dark greenish; skin subrugose, somewhat shining. Body nearly cylindric, slightly thickest on the sixth abdominal segment, with strongly tapering metathorax and mesothorax, slender and attenuate prothorax and strongly retractile head. The median ridge of the head is very prominent in front, shaped like an inverted sled runner. Antennae prominent, slender, two jointed. Mandibles ending in strong, ventrally directed hooks. A ventral pair of slender bristles under both mesothorax and metathorax.

There are stout ventral prolegs on abdominal segments 1-8, paired on all the segments except the eighth, each with a double circlet of hooks at its tip. On segment 1 each proleg is simple, with hooks directed posteriorly. On segments 2-7 each proleg is divided at its apex, becoming double, with the hooks on its two divisions opposed in position [pl.10, fig.2]. On the eighth segment there is a single median proleg with its hooks directed forward, and at its base is a pair of low, broad anal tubercles. There are two pairs of conic, fleshy tubercles on each of segments 1-7 of the abdomen, one tubercle at either side of the dorsum and a longer one at the middle of each side, all increasing in length posteriorly. The abdomen ends on the dorsal side in a pair of long, fleshy processes, stout at base and attenuate to apex, each with a lateral fringe of long hairs each side, on the outer side the fringe extending on segment 8 nearly to its base. Between the bases of these processes on the dorsum of the eighth segment is the single respiratory aperture—a narrow median slit guarded by white lips, on a low convex elevation.

The most remarkable features of this larva are (1) the conformation of the caudal end of the abdomen, (2) the single respiratory aperture and (3) the paired and bifurcated prolegs with their heavy armature of grappling hooks. This grappling apparatus is doubtless correlated with a life spent clinging to the surfaces of rocks in the current of rushing streams.

A note on caddis flies described in Bulletin 47

The identity of the species described on p.569-70 as "3 Halesus sp. ?" has been settled by the rearing of it by Mr Betten at Lake Forest Ill. It is Halesus hostis Hagen. Larvae, in cases like the one shown in plate 33, figure 1 of Bulletin 47, were collected from a spring-fed rivulet late in August. Pupae were found in the breeding cage soon thereafter, and a fine male imago emerged on Sep. 23.

Two excellent German students of the Trichoptera, Ulmer and Weltner, simultaneously and very kindly sent information as to the probable identity of the "egg-ring of an unknown caddis fly" figured on plate 33 of Bulletin 47. Similar egg masses are laid, they say, by the European species Phryganea grandis and Phryganea striata, and this one may well have belonged to our Phryganea cinerea Hagen.

Part 5[1]

AQUATIC CHRYSOMELIDAE
AND A TABLE OF THE
FAMILIES OF COLEOPTEROUS LARVAE

BY ALEX. D. MACGILLIVRAY

Beetles are among the most abundant of insects. They are easily collected and prepared for the cabinet and probably for this reason are more extensively studied and collected than any other order. Their larvae and pupae are usually soft bodied and inconspicuous and in most cases are very difficult to rear to maturity. It is probably due to these latter conditions that the transformations of only a very small proportion of our beetles are known. The habits of their larvae are more varied than those of the other orders; some are predaceous, feeding on the larvae of other insects; some are scavengers, feeding on decaying plants and animals, dried skins, hair and bones; some are herbivorous, feeding on the roots, stems and leaves of plants, mining their leaves, living within their seeds, forming galls on their leaves, or tunneling through the trunks of trees; some feed on and destroy many kinds of prepared food products, while others live commensally within the nests of insects. Though the majority of the species are terrestrial, yet many are found on the surface and within the water of ponds and streams.

There have not been any extended investigations dealing with the transformations of American Coleoptera. The work done thus far consists mainly of scattered descriptions by government and state entomologists in bulletins, reports and entomological magazines, and they have dealt in great part only with those species that are of economic importance in some phase of their life history.

The most important publications for the student of the life histories of American Coleoptera are the following:

Beutenmüller, William. Bibliographical Catalogue of the Described Transformations of North American Coleoptera. N. Y. Micro. Soc. Jour. VII, 1891. 7:1–52.

This paper gives all the references to descriptions and figures of American beetle larvae and pupae previous to this date and should be in the hands of every American student of this subject.

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[1] Not edited according to the rules of the University.

Rupertsberger, Mathias. Biologie der Käfer Europas. Eine Uebersicht der biologischen Literatur gegeben in einem alphabetischen Personen- und systematischen Sach-Register nebst einem Larven-Cataloge. Linz a. d. Donau. 1880. O. 295p.

——— Die biologische Literatur über die Käfer Europas von 1880 an. Mit Nachträgen aus früherer Zeit und einem Larven-Cataloge. Linz a. d. Donau und Niederrana. 1894. O. 310p.

The two papers given above include the references to the literature on the transformations of European Coleoptera. They are useful to the American student for the references to the species common to Europe and North America that they contain. The larger families of Coleoptera are found in both countries, and, by looking up these references, it is possible to determine the type of larvae to be expected in the American fauna in those families where they are unknown.

Schiodte, J. C. De Metamorphosi Eleutheratorum observationes: Bidrag til insekternes udeldviklingshistoire. Kjobenhaven. 1861-83. 2v. O. 86pl.

Each volume is made up of a number of separate parts which were originally published separately in the *Saertryk af Naturhistorisk Tidsskrift*. Though this work deals entirely with European insects, yet the families and genera in most cases are found in this country. The text is written in Latin, the descriptions are very full and suggestive. The figures are excellent; they are printed from copper plates and show the entire form of the larva and pupa, together with many useful structural details.

Perris, Edouard. Larves de Coleopteres. Paris 1887. gr. O. 590p. 14pl. with 579fig.

This work consists mainly of descriptions of larvae and pupae, and the figures deal almost entirely with structural details.

In hope of interesting and aiding others in the study of the transformations of the Coleoptera, the following table has been prepared. It is based in great part on the facts contained in the papers mentioned above and deals only with the more important families. No one can be more conscious of its imperfections than the writer; but a poor tool is better than no tool.

KEY TO FAMILIES OF COLEOPTEROUS LARVAE[1]

a Tarsi with two claws
  b Mandibles of the usual type, with teeth at the base or at middle
    c Abdomen not provided with long, slender lateral filaments
      d Cerci present, in some cases small; ocelli six
        e Abdomen and legs ambulatory; abdomen with eight pairs of spiracles .... Carabidae
        ee Abdomen and legs natatory; abdomen with seven pairs of spiracles .... Amphizoidae
      dd Cerci wanting; ocelli four; with hooks on the dorsum Cicindelidae
    cc Abdomen provided with long, slender lateral filaments which serve as tracheal gills .... Gyrinidae

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[1] In the following table the term setae is applied only to those small hairs that arise from a single hypodermal cell like those of the Dermestidae, Cerambycidae, and Buprestidae; and the term spine is restricted to the strongly chitinized hairs that are developed as projections of the body wall, like those of the Coccinellidae and the Cassidinae of the Chrysomelidae.

bb Mandibles suctorial, without teeth at middle or at base
  c Apex of the abdomen not armed with four hooks...Dytiscidae
  cc Apex of the abdomen armed with four hooks.......Gyrinidae
aa Tarsi never with more than a single claw; in some species the legs entirely wanting
  b Cerci present as jointed appendages, in some cases hardly more than a jointed tubercle
    c Larvae long, wirewormlike; the caudal end of the abdomen strongly chitinized; larvae terrestrial....................Elateridae
    cc Larvae soft bodied, not wirewormlike; the caudal end of the abdomen not more strongly chitinized than the remainder of the body
      d Eyes in groups of five or six
        e Larvae terrestrial, feeding in fungi.........Scaphidiidae
        ee Larvae aquatic
          f Eyes in groups of five.....................Haliplidae
          ff Eyes in groups of six.................Hydrophilidae
      dd Eyes in groups of four, two, or none; larvae terrestrial
        e Labrum present, distinct; body frequently lepismoid in form
Silphidae
        ee Labrum wanting; body not lepismoid in form, the sides subparallel
          f Eyes present, usually in groups of four..Staphylinidae
          ff Eyes wanting............................Histeridae
  bb Cerci wanting
    c Larvae without thoracic legs
      d Head broader than the remainder of the body; the body depressed; larvae wood borers
        e Maxillary palpi with three or four segments; the labial palpi with three segments; eyes frequently present
Cerambycidae
        ee Maxillary palpi with two segments; the labial palpi minute, unsegmented; eyes usually wanting.......Buprestidae
      dd Head not broader than if as broad as the remainder of the body; the body cylindrical; the larvae infesting seeds..Bruchidae
    cc Larvae with distinct thoracic legs
      d Larvae scarabaeoid, that is, white grub-like, in form
        e Eyes present
          f Eyes six in number;. larvae case-bearers
Chrysomelidae
          ff Eyes two in number; larvae not case-bearers Trox
Scarabaeidae
        ee Eyes wanting, or if present, usually of not more than a single ocellus
          f Antennae three jointed, minute, hardly projecting beyond the side of the head; larvae usually small.........Ptinidae
          ff Antennae two to six jointed, never minute, usually as long as, or longer than, the mandibles; larvae usually large
Lucanidae
Scarabaeidae
      dd Larvae not scarabaeoid in form
        e Apex of the abdomen not more strongly chitinized than the remainder nor produced into one or two prominent projections

f Body densely covered with long, fine setae which are generally barbed and frequently aggregated into a pencil at the posterior end of the body..............Dermestidae

ff Body not densely covered with long, fine setae, or, if present, these are minute and never aggregated in the form of a pencil at the posterior end of the body. No account is taken here of the strong black or brownish chitinized spines

- *g* Larvae aquatic
  - *h* Antennae as long as, or longer than, the thorax Dascyllidae
  - *hh* Antennae not as long as the thorax
    - *i* Larvae depressed, with the lateral margins of the segments greatly produced so as to conceal the ventral and lateral portions of the body when viewed from above; with tracheal gills on the abdomen Parnidae
    - *ii* Larvae cylindrical; without tracheal gills
      - *j* Labrum wanting; each body segment usually with four long, filiform appendages; eight abdominal tergum never with a pair of dorsal spines with spiracles at their base............Haliplidae
      - *jj* Labrum present; none of the body segments with long, filiform appendages; eighth abdominal tergum with a pair of dorsal spines with spiracles at their base; larvae feeding on the roots of aquatic plants ....Chrysomelidae
- *gg* Larvae not aquatic
  - *h* The lateral margins of the abdominal tergites dilated so as to conceal the plurae when viewed from above, the dilatations when elongate, narrowed toward the apex
    - *i* Body convex, about twice as long as wide; lateral dilatations blunt and covered with numerous minute setae ....Endomychidae
    - *ii* Body flattened above, distinctly more than twice as long as wide; the lateral dilatations frequently pointed and never covered with numerous minute setae ....Lampyridae
  - *hh* The lateral margins of the abdominal tergites not dilated so as to conceal the plurae when viewed from above
    - *i* Body covered with strong, elongate, black or brownish, chitinized spines
      - *j* Median pair of spines of the eighth abdominal tergite long and modified into a faeci-fork for carrying the cast larval skins and faeci, umbrellalike over the back...............Chrysomelidae
      - *jj* Median pair of spines of the eighth abdominal tergite not longer than the others, and, if any are elongate, it is the median pair of the ninth abdominal tergite

k Median pair of spines of the ninth abdominal tergite distinctly longer than any of the other tergal spines ....Erotylidae

kk Median pair of spines of the ninth abdominal tergite not longer, all the tergal spines subequal in length ....Coccinellidae

ii Body sometimes covered with fine, translucent setae but never with elongate black or brownish chitinized spines

j Body covered with fine clavate setae

k Ninth abdominal tergum with a pair of short, stout, chitinized spines..........Erotylidae

kk Ninth abdominal tergum not with a pair of stout chitinized spines...........Endomychidae

jj Body not covered with clavate setae

k Body completely covered with a white flocculent mass; larvae aphidivorous...Coccinellidae

kk Body never covered with a white flocculent mass

l Larvae provided with abdominal prolegs on at least one abdominal segment
Chrysomelidae

ll Larvae not provided with abdominal prolegs

m Thorax abruptly broader than the head and abdomen; living in burrows of mud or sand in wet places..........Heteroceridae

mm Thorax not distinctly broader than the abdomen, if broader, only gradually so and then only the prothorax markedly so

n Tergum or sternum or both with distinct chitinized areas, frequently prominent, proleglike

o Body usually depressed; the distance between the prothoracic legs greater than the length of the legs
Cerambycidae

oo Body usually cylindrical; the distance between the prothoracic legs not as great as the length of the legs
Oedemeridae

nn Tergum or sternum never with distinct chitinized areas

o Ninth abdominal tergite with two or more short cuticular spines

p Apex of the abdomen obliquely truncate; antennae[1] with three segments
Cioidae

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[1] In counting the segments of the antennae, it is frequently difficult to determine whether the enlarged globular basal portion should be counted as a segment or not. Some writers have considered it simply as a protuberance of the head, while others have looked on it as the first antennal segment. In this table it is considered as a distinct segment.

pp Apex of the abdomen not obliquely truncate; antennae with four segments ....Nitidulidae

oo Ninth abdominal tergite not with short cuticular spines

p Antennae consisting of four segments

q Labrum distinctly present

Nitidulidae

Cucujidae

qq Labrum wanting......Elateridae

pp Antennae consisting of three segments

q Labrum wanting....Lampyridae

qq Labrum distinctly present

Melandryidae

ee Apex of the abdomen strongly chitinized and usually produced into one or more prominent projections

f Entire abdomen strongly chitinized and cylindrical, the apex squarely truncate and not produced into projections

Rhipiceridae

ff Entire abdomen not strongly chitinized and, if so, never truncate at the apex; flattened or cylindrical, and the apex always produced into one or more prominent projections

g Antennae consisting of four segments

h Abdomen strongly chitinized only around the bases of the chitinous projections of the apex of the tergum; usually somewhat flattened

i Last abdominal segment produced into two strongly chitinized and bifurcating processes

j Abdomen strongly depressed..Pyrochroidae

jj Abdomen cylindrical or subcylindrical, not strongly depressed

k Bifurcating process of the last abdominal segment with lateral spines or tubercles

Trogositidae

kk Bifurcating process of the last abdominal segment not with lateral spines or tubercles

Colydiidae

Mycetophagidae

Malachidae

Cleridae

Melandryidae

ii Last abdominal segment produced into a single strongly chitinized process, which is usually slightly angularly emarginate at apex.....Mordellidae

hh Abdomen strongly and evenly chitinized throughout, cylindrical or subcylindrical

i Labrum wanting.....................Elateridae

ii Labrum present and separated from the clypeus by a distinct suture................Tenebrionidae

gg Antennae consisting of three segments
  h Abdomen cylindrical, obliquely truncate at apex, the chitinized apical projection on the dorsal aspect and projecting dorsad....................Cioidae
  hh Abdomen subcylindrical, not obliquely truncate at apex, and the chitinized apical projection at apex and subhorizontal ....Lagriidae

Family CHRYSOMELIDAE

This family includes about 600 species divided into 11 subfamilies. The larvae feed on the leaves of various plants. Two of the subfamilies contain species that feed on aquatic plants. These can be separated as follows:

Larvae

Dorsal surface of the eighth abdominal segment with a pair of pointed spines; abdominal prolegs wanting..... Donaciinae
Dorsal surface of the eighth abdominal segment not with a pair of long spines; abdominal prolegs present......Galerucinae

Pupae

Pupae inclosed in a tough brownish silken cocoon, not attached, and whitish in color......................... Donaciinae
Pupae naked, attached to the leaf surface by the apex of the abdomen, and blackish in color...................Galerucinae

Imagos

Prothorax not with a thin lateral margin.............. Donaciinae
Prothorax with a distinct thin lateral margin..........Galerucinae

Subfamily DONACIINAE

In our fauna this subfamily includes two genera, Donacia with 20 species and Haemonia with a single species. All the species are similar in habit, the larvae feeding on the submerged underground stems of aquatic plants. They have been collected on Nymphaea advena, Sparganium androcladium, Sagittaria latifolia, Sagittaria rigida, and Potamogeton.

It is a well known fact that in all insects that live submerged in water there are special modifications in structure to fit them for such a mode of life. They are either provided with special organs for taking their supply of oxygen from the air mixed with the water, as tracheal gills, or they are so modified that they can carry a supply of air with them. Many water beetles carry a supply of air under their elytra; others carry it on the ventral side of the abdomen and thorax. This supply is replenished and purified by the insect going to the surface of the pond from time to time. By the larvae, pupae, and adults of the Donaciinae, neither of the above methods is in use. In the following pages the method these insects pursue for obtaining a supply of air will be described. The account is based on studies made on the life history of Donacia palmata, which occurs abundantly throughout the summer at Ithaca.

Specimens of Donacia palmata were found most plentiful on the plants of the yellow pond lilies growing in the lagoon extending from the south side of Fall creek just above where it empties into Cayuga lake. It is known as the White Lily pond, because it is the only place where this plant is found at the head of the lake. This lagoon extends off from the main stream in a rather sinuous course for about 200 yards. At no place is the water more than 3 feet deep. The bottom consists of soft loamy ooze about 2 feet deep. It is in this ooze that the underground stems of the yellow pond lily grow. In order to obtain the stems containing larvae, it was necessary to get into the water and pull them up from the bottom of the ooze. Along the banks of the lagoon there was a luxuriant growth of Sagittaria, Pontederia, Polygonum sagittatum, Scirpus, and Typha. It was along here that the larvae and pupae of Donacia aequalis and Haemonia nigricornis were obtained. The conditions existing are well shown by plate 20, where the luxuriant shore growth is represented in the foreground, while the water just beyond is almost hidden by the leaves of the yellow pond lilies floating on its surface.

In the early summer, while the water is deep or the stems are not long enough to raise their leaves above the surface of the water, the eggs are laid on the underside of the leaves of the large yellow pond lily, Nymphaea advena. Growing in this same lagoon there were a number of plants of the white pond lily, Castalia odorata, and as soon as the leaves of Nymphaea were raised above the surface of the water the eggs were deposited on the leaves of this plant [pl. 21, fig. 1]. In June and early in July the beetles were abundant, flitting about on the upper surface of the leaves. As the female beetle apparently can not live submerged in water, she has adopted the ingenious plan of cutting a hole, round or oval, about ¼ inch in diameter in the leaf from the upper surface. She then inserts her long extensile abdomen [pl.30, figs.4-5] through the hole and lays her eggs in a circle on the underside [pl.21, fig.4]. Each mass consists of a double row of eggs, which are fastened together and to the surface of the leaf by an opaque gelatinous substance, which completely covers the eggs [pl.21, fig.4]. The eggs are elongate, the sides are parallel, and each end is obtusely rounded. The chorion is smooth, without surface sculpture and opaque white in color. The beetles do not emerge in definite broods, so that eggs in all stages of development can usually be collected at almost any time during the summer and fall.

The other species of Donacia differ from palmata in the manner and place of laying their eggs. The eggs of cincticornis, whose larvae are also found on the roots of Nymphaea, are laid in a compact mass on the stems of a sedge [pl.21, fig.3], while those of porosicollis are laid in a row along the edge of a leaf sheath of the species of sedge on which the larvae feed [pl.21, fig.2].

The eggs hatch in about 10 days, and the young larvae find their way to the bottom of the pond and among the ooze and attach themselves to the underground stems of the yellow pond lily. Numerous underground stems of the white pond lily were examined, and not a single one was found with the larvae of Donacia attached to it, or with any indications of where larvae had been feeding on it, though in most cases the stems of the two species of plants were intertwined. It is certainly marvelous that these delicate larvae are able to locate themselves in this way, and many of them must fall prey to fishes in their transit.

The larvae just emerged from the egg have all the general characteristics of the mature larvae, with the addition of many long, stiff hairs [pl.27, fig.13]. These hairs are very similar to those found on recently hatched butterfly larvae, as they have been figured by Dr S. H. Scudder.[1] In specimens kept in aquaria it was found that these hairs were soon shed. It has not been possible to determine anything as to their function, though they may have to do with freeing the larva from the eggshell or they may be for entangling a supply of air to be used by the larva till it finds some of the roots of Nymphaea, though this certainly can not be the reason for their occurrence in the larvae of the butterflies.

With such conditions as those under which this study was made it was neither practicable nor possible to follow the larva from the time it left the egg till it began feeding on the roots of Nymphaea. In this pond there was only one species of Donacia larvae found in great abundance feeding on the underground stems of Nymphaea, there was only one species of adult found abundantly on the leaves of the plant, and in both cases this was palmata. There was only a single kind of egg found abundantly that produced Donacia larvae, and this, together with the above circumstances, certainly warrants the conclusion that these were the eggs of Donacia palmata.

When the large underground stems were examined, they were usually found covered with larvae of various sizes and with cocoons [pl.22]. The larvae were found clinging to the larger roots and feeding on the fine rootlets with which the roots are covered. Several roots are shown that appear to be covered with minute tubercles [pl.22*r*]. These tubercles are the places from which the rootlets have been cut off by the larvae. In addition to the above, the larvae also eat holes in the apices of the larger roots. A larva feeding in this way is shown on plate 27, figure 18, where the head, prothorax, and mesothorax are imbedded in the tissue of the plant. Scars showing where other larvae have been feeding are representd at *e* and on plate 28, figure 1*e*. Several nearly mature larvae are shown on plate 22*z* attached to the underground stems. As the stem elongates, new leaf stalks are formed at the growing end. The bases of two of these are shown on plate 22*x*. Just back of these will be noted a number of rough, pitted, ovate areas [pl.22*y*], the leaf scars, the places where leaf stalks were formerly attached. On many of these scars will be seen ovate, cylindrical bodies [pl.22*o*], which are the cocoons. The cocoons are spun by the larvae from silk secreted by glands that open in the mouth. When the cocoons are opened, larvae, prepupae, pupae, just transformed adults, or mature adults may be found at the same time. On plate 22*a* are shown three cocoons from which adults have emerged.

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[1] Scudder, S. H. Butterflies of the Eastern United States. v.3, p.70-73.

The larvae are opaque white or slightly yellowish in color and scarabaeoid in form. The head [pl.28, fig.1] is minute and frequently almost concealed by the pronotum. The eyes are present in palmata, though they are apparently wanting in some other species. The labrum [pl.25, fig.6] is minute and usually four sided; projecting from its distal margin are a number of setae, the marginal setae [fig.6*mg*] which are attached to its ental surface; its disk bears six long setae arranged in pairs, a distal pair [fig.6*ds*], a median pair [fig.6*md*] and a proximal pair [fig.6*px*]; laterad of the discal setae there is on either side a single long lateral seta [fig.6*ls*], and near the discal setae there are one or two pairs of pitlike openings, the sensory spots [fig.6*sn*]. The thoracic segments are rotund, with six short, hooked legs. The abdomen is composed of 10 segments, seven of which are well developed, but the last three are minute and curved beneath the sixth and seventh.

There seems to be considerable disagreement as to the number of segments that are present. Perris[1] considers all that portion beyond the seventh [pl.27, fig. 17 and 19] as one segment, Heeger that it is made up of two segments, while Schmidt-Schwedt[2] and Sanderson[3] consider this portion to be made up

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[1] Perris, E. Histoire des Metamorphoses de la Donacia sagittariae. Ann. Soc. Ent. Fr. (2) 1848. 6:33-48, pl.2, no. 2.

[2] Schmidt-Schwedt, E. Noch einmal über der Athmung der Larven von Donacia crassipes. Berl. Ent. Zeit. 1889. 33:299.

[3] Sanderson, E. D. The larvae of Donacia piscatrix Lac., and crassipes Fab. Can. Ent. 1900. 32:252.

of three segments, an eighth, ninth, and a minute tenth. When the dorsal aspect of the segments in front of this region is studied, they are found to be divided transversely into two subsegments, each subsegment bearing a transverse band of setae. If we compare this with the region behind the seventh segment, we find that there are four indistinctly marked transverse divisions, each bearing a band of setae, which would seem to indicate that we have to do with two segments. But, when the ventral aspect is studied, we find that the transverse divisions separating the segments into subsegments are wanting, and that each transverse line marks the suture between two segments, and, when the portion beyond the seventh segment is examined, there are found two transverse divisions [pl.27, figs. 17 and 19], which proves conclusively that this portion is made up of three segments, making 10 abdominal segments in all. The first transverse division on the dorsal aspect caudad of the seventh segment is the suture dividing the eighth segment into subsegments; the ninth and 10th segments are not divided into subsegments. These conclusions are apparently refuted by plate 28, figure 17, where only a single ventral division is shown beyond the suture of the seventh segment, but a few sections on either side of the one from which this figure was made show two well marked ventral divisions.[1]

Each segment bears a number of minute hair-like setae. The arrangement of these setae into definite areas and the interrelation of the areas seem to furnish the best characters for separating the larvae of the various species. It has been found necessary for the sake of exactness and brevity to apply names to these areas [pl.30, fig.1] which are as follows:

The tergal setae are the double row of transverse setae on the dorsum of each segment, the anterior row being known as the anterior tergal setae [fig.1*at*] and the posterior row as the posterior tergal setae [fig.1*pt*].

The supraspiracular setae are the patches of setae between the spiracles and the tergal setae [fig.1*ss*].

The infraspiracular setae are the small patches of setae immediately beneath the spiracles [fig.1*is*].

The pedal setae are the patches of setae surrounding the thoracic legs and on the protuberances where the prolegs would be situated if they were present [fig.1*ps*].

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[1] "The long filiform lateral appendages" referred to by Mr Sanderson as figured by Kolliker, A. Observationes de prima insectorum genesi adjecta articulatorum evolutionis cum vertebratorum comparatione. Observationes de prima insectorum genesi. Ann. des Sci. Nat. (2) 1843. 20:267-99, pl.12, fig.6, are the deciduous setae represented on pl.27, fig.13; and I can not see how they can have any bearing on the question of the homology of the segments.

The sternal setae are the patches of setae on the ventral side of each segment between the patches of pedal setae of either side [fig.1*st*]. The sternal setae of the thoracic segments are frequently divided transversely into two groups: the anterior group may be known as the anterior sternal setae [fig.1*ast*] and the posterior group as the posterior sternal setae [fig.1*pst*].

In the figures representing the setae of the thorax and abdomen, the plan originally devised by Dr Friedrich Brauer for showing the setae occurring on the larvae of the Oestridae or bot-flies has been followed. By this method each segment is represented as a parallelogram and the topographic arrangement of the setae indicated by dots.

There are nine pairs of spiracles present; one pair is situated on the cephalic margin of the mesothorax and eight pairs on the first eight abdominal segments. The spiracles on the first seven abdominal segments are small and, so far as is determinable from their histological structure, are functional. The first abdominal spiracle is on the lateral aspect of the body, but the succeeding pairs gradually converge toward each other till the eighth abdominal segment is reached, which contains a pair of large active spiracles, opening on the dorsal surface, one on either side of the meson.

Associated with the spiracles of the eighth abdominal segment, there are a number of well marked sclerites. The largest and most prominent is a thick and well chitinized peritreme which completely surrounds the spiracular opening except in front at middle, where there is a very evident interruption [pl.27, fig.19*p*]. Cephalad and laterad of the peritreme there is a prominent sclerite, the anterior sclerite, which is of about the same size as the peritreme and distinctly separated from it by a well marked furrow [fig.19*as*]. This sclerite varies slightly in position and extent in different specimens. In some cases its mesal end is interpolated between the peritreme and the caudal end of the apodeme and in such cases usually contains a prominent, lateral, tongue-like projection. Projecting cephalad from each cephalo-mesal angle of the sclerite just described, there is a long thread-like sclerite, which is one of the chitinized sides of a large dorsal apodeme which is invaginated just in front of and between the anterior sclerites. This apodeme, together with the anterior sclerites, serves for the attachment of a complicated system of muscles which are used in moving the caudal spines. Plate 27, figure 14, represents a longitudinal section of this apodeme, showing the attachment of 11 distinct groups of muscles. The opening of this apodeme was mistaken by Mr Sanderson for the opening of the rectum. On plate 28, figure 17*al*, is represented a median longitudinal section of the alimentary canal of the three apical abdominal segments, where the position of the rectum is shown at *rec* and the position of the apodeme at *da*.

Projecting from the caudal margin of each peritreme is a long pointed spine which extends from the eighth abdominal segment to or near the apex of the abdomen [pl.27, figs.18-19*cs*]. These are the caudal spines. On plate 28, figure 2, a lateral view of one of these spines is shown enlarged, together with its connection with the peritreme, *pe*, the cuticular pocket into which the spiracle of the eighth abdominal segment opens, *cp*, and the outer end of the dorsal apodeme, *da*. Figure 3 represents the apex of a spine still more enlarged, so as to show the teeth on its ventral side. If a spine is examined in cross section near the middle of its length [pl.28, fig.2*d-e*], it will be found that it is ovate in outline [pl.28, fig.4], the dorsal surface evenly convex, the sides somewhat flattened, and the ventral surface produced into a prominent angle. The cuticle of the dorsal and lateral surfaces is thick and strongly chitinized, while on the ventral surface the cuticle is thin, soft, and hardly chitinized at all. This is more marked at the base of the spines and is evidently to allow for a freer dorso-ventral motion. The interior of the spine at this point contains 10 cavities, which may be divided into two classes, those containing hypodermal cells and those that are empty. Those of the first class are the largest and most important and will be considered first. Beginning at the ventral side, the angular portion is filled by a large ovate shaped cavity which has a tongue-like projection extending four fifths the length of the section [fig.4*vc*]; on either side of this tongue-like projection is a large cavity, which is ovate in outline, its mesal sides straight, and with a large tooth-like projection extending into its dorso-lateral portion [fig.4*pvc*]. Dorsad of each of the cavities just described there is another much smaller cavity, which is almost round in outline [fig.4*pdc*] and dorsad and mesad of each of these, there is a single minute cavity which is completely filled with cells. The three ventral hypodermal cavities [fig. 4*vc* and 4*pvc*] are continuous with the cavity at the base of the spines, the three dorsal hypodermal cavities [fig. 4*dc* and 4*pdc*] are cross sections of pockets that have probably been formed from infoldings from the dorsal tongue-like portion of the ventral cavity. The cavities of the second class are minute, four in number [fig.4*cc*], a pair laterad and another pair dorsad of the dorsal pair of hypodermal cavities.

If another section is examined near the body at the point *f-g* indicated on plate 28, figure 2, it will be found that the three ventral cavities are much larger [pl.28, fig.5], that the three dorsal cavities have entirely disappeared, and that the cuticle, while of about the same thickness, is not so strongly chitinized except around the periphery of the spine and the periphery of the ventral pair of cavities [pl.28, fig.5*pc*]. Then, if a section is taken at the point *h-i* [pl.28, figs. 2 and 8], it will be noted that the cuticular wall of the ventral side of the spine [pl.28, fig.6] is continuous with the body wall of the eighth abdominal segment, and that the ventral cavity is merged into the cavity at the base of the spine, while the ventral pair of cavities have moved nearer the dorsal surface of the spine, and the portion represented in figures 4 and 5, *pvc*, as filled with hypodermal cells is at this point filled with cuticle, which completely fills the cavity. Figure 17 of plate 28 represents a sagittal section through the apex of the abdomen and through one of the caudal spines, *cs*, the section passing mesad of the spiracular opening. At the base of the spine should be noted the cuticular pocket, *cp*, which extends into the paired ventral cavities at the base of the spine, and the thick layer of hypodermal cells, *hcp*, surrounding the cuticular pocket. The base of the spine and its related portions are shown at figure 8 still more enlarged. The section from which this figure was drawn was taken laterad of the spiracular opening. In this figure should be noted likewise the paired ventral cavities, *pvc*, the ventral cavity, *vc*, and the cuticular pocket, *cp*. It shows also the intimate relation existing between the paired ventral cavities and the cuticular pocket, the cuticular wall of the pocket extending into the bases of the cavities like a wedge and completely closing them, as was described above [pl.28, fig.8*w*]. Figure 11 is a cross section taken at about the point *j-k* of figure 8 and shows the pair of marked cuticular thickenings which form the proximal ends or bases of the paired ventral cavities, *pvc*, the large cavity contained between and around the cuticular thickenings, and the caudal part of the spiracular opening, which in this section does not communicate with the exterior. The spiracle opens directly at the base of the spine [pl.27, fig.19*s*] and extends from the surface in a cephalo-ventral direction into the cuticular pocket. On plate 28, figure 10, is shown a section cephalad of the one just described, which shows the external communication of the spiracle and the heart-shaped cuticular mass which forms the cuticular pocket, the heart-shaped form being derived by the gradual extension of the cuticle into the cavity lying between the cuticular thickenings forming the bases of the paired ventral cavities. Figure 13 represents a section taken at about the level *l-m* of figure 8. It is located cephalad of the spiracular opening and shows how the air passage, *os*, extends cephalo-ventrad into the interior of the cuticular pocket.

Figure 9 is still further cephalad and is taken at about the level *n-o* of figure 8, and shows the cuticular pocket entirely separated from the body wall and the thick cuticular wall inclosing the air passage on the dorsal side and its almost complete thinning out on the ventral side to allow for the entrance of the trachea. Figure 12 represents the air passage as crowded still farther on to the ventral side by the thick chitinous walls, while figure 7 shows the solid cephalic end of the cuticular pocket and the tracheal trunk almost completely separated from it, with three thick bands of muscles near the ventral end of the trachea which extend to the dorsal apodeme and the body wall and are effective in holding the trachea in place.

The trachea from each spiracle extends cephalad and mesad for a short distance, where they are united by a short transverse tracheal trunk [pl.28, fig.14*ttr*]. From their dorsal and mesal angle extend pronounced cuticular thickenings, from which muscles extend to the dorsal apodeme, *da*, and other muscles in turn extend from the apodeme to the body wall. From the common union just described there extends on either side as far as the head a single tracheal trunk, which is ovate in outline in transection, the long diameter being seven or eight times the short diameter, while the taenidia are long and greatly thickened and are arranged like a series of parallel rods along each face of the trachea. This arrangement of the taenidia and shape of the trachea permit its being expanded and used as a reservoir for storing the air between air-taking periods. The taenidia are shown in transection on plate 27, figure 15*t*, which is a section across the short diameter of the trachea, and in surface section by figure 16*t*. The tracheal trunks extending from the large lateral trunks to the spiracles of the other segments are of the ordinary type, cylindrical and with fine spiral taenidia.

The cuticle forming the cuticular pocket consists of long, fine and closely appressed plates or lamellae, which seem to be intracellular in origin. In specimens stained in borax carmine it is possible to trace fine branches of the protoplasm of the cells extending in between the lamellae throughout their entire length [pl.28, fig.15*pf*], and, when these plates are examined under a high power of the microscope, it is found that there is an anastomosing of the protoplasm of the adjacent branches [pl.28, fig.16], so that each cuticular area is surrounded on all sides by protoplasm.

When cross sections at the caudal end of the spiracle of the eighth abdominal segment are examined, it is found that the cuticle forming the cuticular pocket lies apparently in a natural cavity without any adjacent hypodermal cells. Such a cavity is represented on plate 28, figure 11*ccp* in cross section and at figure 8*ccp* in longitudinal section. In the latter case it will be noted that the cavity is continuous with the ventral cavity of the dorsal spines described above. In the drawings representing the epithelium surrounding the cuticular pocket, the outlines of the cells are not shown, because they could not be made out with certainty on the preparations. Because of the necessity for determining the homology of the threads of protoplasm extending between the lamellae of the cuticular pocket, whether more than a single thread arose from a single cell, which could not be done, it was thought best to leave out the cell boundaries. The preparations represented by the drawings give one the impression that we have to do with a syncytial structure, but it is not improbable that more carefully fixed material would show cell outlines. As it is almost axiomatic that, wherever cuticular structures are found in the Hexapoda there are epithelial cells closely associated with the cuticle from which they are derived, an explanation of the conditions existing here is thought necessary. The hypodermal cells, where they are adjacent to the cuticle and where they inclose the cavity, are long and well marked, while the cavity is filled with a homogenous, lymph-like staining structure. The specimens studied were not originally intended for histological study; the entire larvae were dropped into hot water and thence into either hot Perenyi's solution or hot vom Rath's picro-sublimate. The first impression on studying this structure was that it was an artifact due to improper fixation. But, when several series had been examined and it was found that the location and extent of the cavity was practically the same in all, this explanation had to be given up as improbable. The distance of the cuticle from the hypodermal cells sets aside the possibility of its always having been a cavity and that the structureless substance within the cavity is blood, because, if accepted, we have to meet the more difficult problem of explaining how the cuticle adjacent to the cavity could have been formed. The prevalence of histolytic changes taking place among insects might make this a way out of the difficulty were it not that, in all the sections I have examined, I have never found an undoubted leucocyte within this cavity, while in most cases they were abundant in the body cavity adjacent to the hypodermal cells, and, in addition to the above, there was no indication of any histolysis taking place in any other part of the body. No hypothesis concerning this cavity is tenable other than that it was originally completely filled with the hypodermal cells that surround it and that its present condition is an acquired one. If sections are examined at about the level *l-m* of figure 8, plate 28, of which figure 13 is such a representation and which is the cephalic limit of this cavity, we shall find that some of the hypodermal cells, as at *vh* are filled with vacuoles, in the sections caudad of the one represented here, the vacuoles in places so completely fill the cells that there are left only delicate threads extending between the cuticle and basement membrane, while the cavities of the vacuoles are either empty or filled with a homogenous, nonstainable substance. Though it seems almost impossible to conceive how such a large cavity could have been formed by the vacuolization of the inner ends of the hypodermal cells, yet I have been unable to find any other explanation that would comply with all the conditions existing here. By this hypothesis we are able to explain the origin of the cuticle, which is the most difficult condition to explain and was unquestionably formed before the origin of the cavity. There undoubtedly exists some relation between this cavity and the dorso-ventral motion of the caudal spines. In all probability this motion, after the cells were modified into threadlike extensions, ruptured these threads, and in this way was secondary to the vacuolization of the cells in the formation of the cavity. I hope later to investigate this problem further and determine definitely if possible the origin of the cavity.

As was pointed out above, the larvae of Donacia palmata live at a depth of from 3 to 4 feet under water and ooze and yet have none of those structures common to insects that would fit them for such a mode of life. What to the writer has been the most interesting phase of this investigation has been the determination of how these insects are able to obtain a supply of air. The most casual observers have noticed in walking over swampy places where there is an abundance of submerged vegetation that at each step great quantities of bubbles rise to the surface. These bubbles come in part from the crushed stems of the plants that have been trod on and are an ocular demonstration of the abundant air supply held by such plants. If one of the stems of an aquatic plant as Sagittaria be taken and sectioned transversely [pl.24, fig.1] we shall find that it is made up of a great quantity of small cells arranged in the form of anastomosing rings inclosing large spaces, and that fully two thirds of the area of the section is occupied by these spaces. Now, if another stem is sectioned longitudinally [pl.24, fig.2], we shall find that the cells are arranged in parallel rows with delicate cross walls dividing the longitudinal spaces into areas three or four times as long as broad. Each of these spaces is filled with air, and it is on such a supply that the larvae and pupae of Donacia depend. The larvae tap the air supply locked up in the stems of aquatic plants by pushing their caudal spines through the epidermis of the plant and rupturing the cells surrounding the air spaces. The air contained by such plants is of about the same richness in oxygen as the surrounding atmosphere. When the tissue of the plant is ruptured, the inclosed air, being lighter than the water, moves to the outer surface of the plant, and, if there were nothing to collect it, it would pass on to the surface of the water. But the spiracular openings being at the immediate base of the spines [pl.27, fig.19*s*] and the larva holding the apex of its abdomen close to the surface of the plant, the air is collected before it can escape into the water. Plate 28, figure 1, shows the apical portion of a growing stem with a larva with its caudal spines inserted into the tissues of a plant and in the act of respiring. On the many stems examined were found numerous examples of larvae with their caudal spines pushed into the tissue of the plant clear up to their bases. In every case noted the larvae were at the apex of vigorously growing stems. As was described above, the larva eat large round holes in the apices of the growing stems, and this gnawing of the holes is undoubtedly done while the larva is respiring, as I have observed many larvae in the characteristic attitudes shown on plate 28, figure 1, and plate 27, figure 18. These figures, I think, show the larvae in a frightened attitude, which resulted from pulling the plant from the mud, and, as a result, one larva stopped feeding while the other stopped respiring.

Every investigator who has studied the function and structure of the caudal spines has arrived at a different conclusion. Perris, who studied Donacia sagittariae in 1848, was unable to determine the function of the caudal spines and thought there was a delicate membrane, that is the spiracles at the base of the spines, stretched over the opening, and that there was an osmotic interchange of the air of the tracheal system with that on the exterior of the membrane; but, when we consider the size of the membrane and that there is water, not air, on its exterior surface, this suggestion is seen to be incorrect. Von Siebold, who studied Donacia linearis in 1859, concluded that the openings at the base of the spines were functional spiracles, and that the larva obtained its air supply from the intercellular air spaces of the plant, and this was accomplished by the larva eating a hole into the tissue of the plant, into which it later inserted its caudal spines. From what follows it will be seen that von Siebold came nearest to the correct interpretation of the conditions existing here of any of the investigators. The next investigator to consider this question was Dr E. Schmidt-Schwedt in 1887, who studied the larva of Donacia crassipes. He found that some larvae, kept in a breeding cage, would, when the cage was darkened, insert the tips of their caudal spines into the tissue of the roots, but removed them as soon as the cage was lighted again.

This led him to study cross sections of the caudal spines, in which he found five cavities, two pairs above and a single large unpaired cavity below, which he thought opened near the tip.[1] From this he was led to conclude that the larvae, after inserting their caudal spines into the tissue of the plant, were able to draw the air in through this opening, through the ventral cavity of the caudal spines, and thence into the tracheal system and that there were no openings in the so called spiracles at the base of the spines. If Schmidt-Schwedt had studied the relation of the tracheal system to the caudal spines, he would have seen the fallacy of his conclusions. As I have pointed out above, this cavity is lined with hypodermis, does not connect in any way with the tracheal system, and is closed at its base by a thick layer of hypodermal cells [pl.28, fig.8*w*]. If plate 28, figure 2, is examined, it will be noted that there is a line, *vv*, extending almost the entire length of the spine, which marks the ventral boundary wall of the paired ventral cavities, *pvc*, which are strongly chitinized and can be readily seen through the exterior of the spine when it is studied in optical section. It was the apex of this cavity which Schmidt-Schwedt mistook for an opening.

Dewitz[2] in 1888 published a short paper on the structure borne by the eighth abdominal segment in Haemonia equiseti, in which he maintains that there are no openings in the caudal spines and that the structures at the base of the caudal spines are open spiracles directly continuous to the tracheal system.

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[1] Though Schmidt-Schwedt figures such an opening, yet I reproduce his own description as a proof that he never saw such an opening. "Bei mikroskopischer Betrachtung des ganzen Anhangs kommt man zu der Auffassung, derselbe sei einfach hohl und auf der Unterseite in seiner ganzen Länge mit einem Längspalt versehen. Querschnitte zeigten, dass dies ein Irrthum und dass der innere Bau ungleich verwickelter ist. . . Der 5te unpaare Kanal ist hohl und von zarterer Wandung umgeben; auch auf der Unterseite ist er geschlossen. Nach der Spitze zu verjüngt er sich mehr und mehr und hört noch vor derselben ganz auf. Hier muss er offen sein. Zwar habe ich das an Querschnitten mit vollständiger Sicherheit nicht festsellen können, ebenso wenig wie das Gegentheil, aber es ergiebt sich das Erstere aus dem Umstand, dass sich dieser Kanal und zwar nur dieser beim Einlegen in Paraffin oder Stearin stets alsbald völlig mit der Einbettungsmasse anfüllte. *Berl. Ent. Zeit.* 1887. 31:328-29

[2] Dewitz, Dr H. Berl. Ent. Zeit. 1888. 32:5-6.

The following year Schmidt-Schwedt[1] replied to Dewitz, admitting that the organs at the base of the spines were true spiracles, but probably used only for expelling impure air, while the air in the plant cells was taken up by a double row of transverse slits found on the dorsal side of each caudal spine. Where these slits occur, they fit like a tongue and groove and are perfectly concealed. The air finds its way through the slits into the paired dorsal cavities and then by means of openings between the paired dorsal cavities and the paired ventral cavities, enters the paired ventral cavities along which it follows to the cuticular pocket. The rod-like cuticular structure of the cuticular pocket was known to Schmidt-Schwedt and though from the study of serial sections of this region he could not find any indication of an opening leading from the paired ventral cavity into the cuticular pocket, yet from numerous physical experiments, such as heating larva to drive out the air and then trying to determine its course, he maintained that the air found entrance from the paired ventral cavity through the walls of the cuticular pocket.

In 1900 E. Dwight Sanderson reviewed the work that had been done hitherto and made some original investigations on the structure of the caudal spines. He concluded that the ventral canal had absolutely no connection with the tracheal system, but that "the two upper passages," that is the paired dorsal cavities, "are open above, but can be readily closed by a wedge-shaped piece which runs along the top of the appendage," and that "the lateral passages," that is the paired ventral cavities, "open into the tube surrounding the spiracle," and that there is a double series of elliptical openings along the upper part of each lateral passage and that from these elliptical openings arise several tubes, each of which resembles a coarse miniature gill. He was unable to determine whether these tubes are open at the tips or not, but, if so, thought that they probably act as a sieve through which the air is admitted into the lateral passages; but he rather inclined to the view that they are closed, and that we have to do with a special structure for aerating the tracheae by osmosis. Sanderson's conclusions, to state them in another way, were that the paired dorsal cavities [pl.28, fig. 4*pdc*] are connected with the exterior at the point *ex*, and that the wedge-shaped apical portion of the caudal spines can be shut down tightly on either side so as to close this opening, and that the air finds its way from the paired dorsal cavities through a tube into the paired ventral cavities and thence is carried along this cavity to the tracheal system. From my own studies I have been led to conclude that there is never a natural opening leading into the paired dorsal cavities, and that, when there is such an opening present, it is an artifact. The cuticle at this point is thin and easily broken, while the cavity is lined with hypodermal cells; and I do not know of such a condition existing anywhere among the Hexapoda where there is a cavity opening to the exterior and lined by an epithelium. It is true that the mouth and rectal openings are lined with epithelium, but in both of these cases the lumen end of the cells is covered by a well marked cuticle. In addition to the above, I have found that the wedge-shaped portion is always rigid and not capable of any motion, while any air that might find its way into the paired ventral cavities, if an opening did exist, would be unable to reach the tracheal system, because the base of this cavity is completely plugged up by a portion of the cuticular pocket, as has already been described [pl.28, fig.8*w* and fig.6*pvc*]. I have been unable to find any tubes such as Mr Sanderson describes, while his so called elliptical openings are not openings but areas in the cuticle, that are very thin and transparent and very liable to lead one into error if one worked only with thick free-hand sections. When the caudal spines are mounted in Canada balsam, so that their dorsal surface can be studied, two rows of these elliptical openings can be seen forming the ectal surface of apparently well marked grooves or furrows, but these grooves or furrows are nothing more than the cavities of the paired dorsal cavities into which one looks through the transparent outer cuticle. This is further confirmed by the study of cross sections of the caudal spines;

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[1] Schmidt-Schwedt, Dr E. Berl. Ent. Zeit. 33:299-308.

for, no matter at what level sections are taken, the dorsal surface is always found to be convex, as is represented on plate 28, figure 4.

In order to explain how the larva of Donacia obtains its supply of air from the intercellular spaces of plants, I do not think it is necessary to assume any extraordinary structures for the caudal spines. The caudal spines are nothing more than projections of the body wall for rupturing the tissues of the plant; and, when this is accomplished, the air, being so much lighter than the surrounding water and having a strong tendency to follow along anything that will carry it to a higher level, simply follows along the outer surface of the caudal spines to their base, where it is taken up by the spiracles, while the two large longitudinal trachea connecting with the spines take up the supply of air and act as reservoirs for storing it between the air-taking periods.

When the larvae are ready to transform to pupae, they spin a tough, brownish cocoon, which is attached to the scars on the upper surface of the rhizome from which the leaf stalks have been shed. The silk is spun from glands opening in the mouth. The cocoons are not only water-tight but air-tight and are of a homogeneous consistency throughout without any indication of a thread-like structure. The bottom of the cocoon where it is attached to the plant is much thinner and lighter in color and is firmly glued to the surface of the plant [pl.22*o*]. In the case of palmata the cocoons are much smaller than the rhizome and always placed on its upper surface, distant from each other; but in those species that pupate on the roots of Sagittaria, Sparganium and Potamogeton, the cocoons are much broader than the roots and are placed singly, usually near the point of attachment of the roots to the base of the plant. Such a condition is shown well by plate 23, figure *b;* while in the case of Donacia cincticornis, which fastens its cocoons to the larger roots of Nymphaea advena, they are arranged close together in groups of five or six around the apices of the roots.

If the place from which a cocoon has been removed is examined, there are found two slits near one end [pl.30, fig.6*css*] and a circular excavation near the center which penetrates through the cocoon into the tissues of the plant [pl.30, fig.6*bh*]. These slits were undoubtedly made by the caudal setae, as the openings are of the same size as the setae and the same distance apart and I believe it is the place where the larva was attached for the purpose of respiration while it was spinning its cocoon. Though numerous underground stems containing larvae were examined, yet I have never found a larva in the act of spinning its cocoon nor opened a cocoon with a larva with its caudal setae inserted in the slits. In every cocoon examined containing larvae except one, the caudal setae were in the opposite end of the cocoon from the slits, and in those cocoons containing pupae, the cast larval skins were in the opposite end of the cocoon from the slits. The only other way in which the slits could have possibly been made was by the mandibles, but, when they are studied and their weak structure and their shortness are noted, the impossibility of this explanation is apparent, and one is forced to the conclusion that there is no way that the slits could have been made other than by the caudal spines, and that the larvae must turn around in their cocoons after its completion and before shedding their last larval skin. In the case of the single exception noted the larva had probably completed its cocoon and had not yet turned around. The cocoons are usually larger than the inclosed larva, so that there would be room for it to turn around if it so desired. In the cocoons of Donacia aequalis and Haemonia nigricornis the circular excavation near the center of the bottom of the cocoon is wanting, and the pupa has to depend entirely on the air that can reach it through the paired slits.

Not only is the attachment of the larvae at the time they are spinning their cocoons important for furnishing an adequate supply of air for the larvae while they are undergoing the greatest muscular activity of their life, but an abundant supply of air is also undoubtedly important in freeing their cocoons of water. If, when the cocoon was completed, it were filled with water, then, when the larva transformed to a quiescent pupa, it would be drowned in its own coffin. Such a calamity is undoubtedly averted by the larva entirely surrounding itself while spinning its cocoon by a quantity of air sufficient to fill the vacant space in the cocoon. A small quantity of water might be absorbed by the body of the larva or pupa, but it does not seem possible that the insect could absorb the amount of water the cocoon would hold; while, on the other hand, the underground stems to which the cocoons are attached are always imbedded in a soft, clayey ooze, and, if the water were absorbed by the body of the insect, then the interior of the cocoon would be lined with a clay deposit which would discolor it, whereas in every case the interior of the cocoons were just as clean as if they had been spun in the open air. It would be impossible for the plant to absorb the water because the bottom of the cocoon would be between the water and the epidermis of the plant except at the paired slits and the opening near the center.

The large excavation is always near the center of the cocoon and is undoubtedly made by the larva before transforming to a pupa. In this way the larva provides a continuous air supply for itself by tapping the store held in the intercellular air spaces of the plant. Since some individuals of Donacia live for 10 months or more in the cocoon, need for a copious and continuous air supply becomes apparent. That there is a bountiful supply can be readily proved by opening the cocoons under water, when it will be found that they are completely filled with air.

The pupa transforms to a beetle long before it is time for it to emerge. When it is ready to emerge, the end of the cocoon is broken off and the beetle crawls out. The ventral surface of most of the species of Donacia is densely covered with fine silken hairs, so that, when the beetle emerges from its cocoon, the air contained in the cocoon at this time is held to the ventral surface of the beetle by these silken hairs and in this way provides an air supply for it till it reaches the surface of the water. This silken covering is also of use to those species that lay their eggs under water.

KEY TO GENERA OF DONACIINAE

Larva

Sixth and seventh abdominal tergites each with a double row of setae of the same length as those found on the other tergites; the supraspiracular setae always present..Donacia

Sixth and seventh abdominal tergites each with a double row of setae, most of which are twice as long as those found on the other tergites; the supraspiracular setae wanting........................Haemonia

Pupa

Tarsal segments expanded at either side; the elytra usually truncate at apex ....Donacia

Tarsal segments of a uniform width; the elytra usually excised with the outer angle strongly and the inner angle slightly prolonged at apex.... Haemonia

Imago

Tarsi dilated, spongy beneath; the fifth segment of the tarsi subequal to or shorter than the second and third together...............Donacia

Tarsi not dilated, narrow, glabrous; the fifth segment of the tarsi distinctly longer than the second and third together.........Haemonia

DONACIA

The beetles of this genus are known as the long-horned leaf beetles because of their great resemblance to the species of the family Cerambycidae. They are elongate in form and of a greenish, bronze or purplish metallic color. The antennae are long and slender; the underside of the body is clothed with fine hair, giving them a silvery metallic appearance.

Species of Donacia are found in all parts of the United States and Canada, but they are more abundant in the northern, eastern and middle portions. Twenty species have been recognized which can be separated, so far as they are known, by means of the following tables:

Eggs

a Eggs large, 5mm long..............................cincticornis

aa Eggs small, not over 2mm long

- *b* Eggs covered with a gelatinous secretion, laid in a double row around a circular opening in a leaf..........................palmata
- *bb* Eggs not covered with a gelatinous secretion, and laid in a single row along the margin of a sedge leaf.................porosicollis

Larva

a Supraspiracular setae of the first four abdominal segments not extending caudad as far as the front margin of the posterior tergal band of setae

b Supraspiracular setae of the first six abdominal segments forming a single continuous group of setae
  c Sternal setae of the fifth abdominal segment divided longitudinally by a mesal line into two groups; the posterior sternal setae of the mesothorax undivided
    d Sternal setae of the seventh abdominal segment distinctly divided into two groups; the infraspiracular setae of the seventh abdominal segment not longer than broad...cincticornis
    dd Sternal setae of the seventh abdominal segment continuous; the infraspiracular setae of the seventh abdominal segment twice as long as broad..................................palmata
  cc Sternal setae of the fifth abdominal segment not divided; the posterior sternal setae of the mesothorax not divided longitudinally into two groups
    d Supraspiracular setae of the sixth and seventh abdominal segments coalesced with the outer ends of their posterior tergal setae ....subtilis
    dd Supraspiracular setae of the sixth and seventh abdominal segments not extending as far caudad as the posterior tergal setae porosicollis
bb Supraspiracular setae of the first six abdominal segments divided transversely into two well marked groups.............aequalis
aa Supraspiracular setae of the first five abdominal segments extending caudad as far as the caudal margin of the posterior tergal setae emarginata

Pupa

a Antennae with the third segment distinctly longer than the second palmata
aa Antennae with the second and third segments subequal
  b Prothorax distinctly tuberculate on the side; the pronotum with an impressed line at middle..............................aequalis
  bb Prothorax not tuberculate on the side; the pronotum not with an impressed line at middle
    c First abdominal segment as long as, or longer than, the next four segments
      d Mesosternum between the coxae nearly as broad as the coxae cincticornis
      dd Mesosternum between the coxae about one half the width of the coxae or less....................................subtilis
    cc First abdominal segment as long as the next three segments emarginata

Imago[1]

a Head and thorax evidently pubescent above
  b Elytra without pubescence
    c Posterior femora with a small tooth..............hirticollis
    cc Posterior femora simple...........................pubicollis
  bb Elytra evidently pubescent; posterior femora toothed..pubescens

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[1] This table was compiled from a table by Charles W. Leng. Revision of the Donaciae of Boreal America. Am. Ent. Soc. Trans. 1891. 17:159–76.

aa Head occasionally, thorax never, pubescent

b Elytra truncate or subtruncate

c Form decidedly flattened, mesosternum about as broad as each coxa

d Thorax narrowed in front; posterior femora pluridentate in the male, simple in the female........................floridae

dd Thorax quadrate, or wider in front; posterior femora dentate in both sexes, the male often bidentate or tridentate

e Antennae with the second and third segments nearly equal cincticornis

ee Antennae with the third segment much longer than the second

f Elytra truncate; first ventral segment of the male not depressed at middle

g Anterior tarsi of the male dilated............palmata

gg Anterior tarsi of the male simple...........hypoleuca

ff Elytra subtruncate; form more convex; first ventral segment of the male depressed at middle............piscatrix

cc Form more convex; mesosternum narrower than the coxa

d Eyes of normal size; sutural margin of the elytra straight, except in distincta

e Thorax punctate, not, or scarcely, tuberculate

f Thoracic punctures coarse, uniform; median furrow not distinct and punctured at bottom

g Second and third segments of the antennae subequal subtilis

gg Second segment of the antennae about one half the length of the third................................rugosa[1]

ff Thoracic punctures uneven, thorax rugose with punctures between the rugosities; median furrow distinct, entire, and not punctured at bottom................porosicollis

ee Thorax uneven on the disk, tuberculate on the sides

f Sutural margin of the elytra straight

g Elytra with transverse indentations..........aequalis

gg Elytra not with transverse indentations; posterior femora of the male dentate, simple in the female tuberculata

ff Sutural margin of the elytra sinuate...........distincta

dd Eyes small; thorax tuberculate; sutural margin of the elytra sinuate ....harrisii

bb Elytra rounded at tip; the sutural margin sinuate posteriorly; form convex; mesosternum narrow

c Thorax depressed without basal and medial grooves

d Posterior femora dentate in both sexes..............pusilla

dd Posterior femora dentate in the male only........femoralis

cc Thorax convex, punctured, and with an evident basal and a more or less evident medial groove

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[1] This form is considered a variety of subtilis by Mr Leng, but, if the character given above is worthy of group value in the case of cincticornis, palmata, hypoleuca, and piscatrix, I can see no reason why rugosa should not be entitled to specific rank, and have so considered it here.

d Posterior femora pedunculate; thorax closely punctulate
  e Legs dark
    f Posterior femora dentate in both sexes......emarginata
    ff Posterior femora dentate in the male only.....metallica
  ee Legs rufo-testaceous; posterior femora dentate in both sexes flavipes
dd Posterior femora elliptical, dentate in both sexes; thorax sparsely punctured; legs rufo-testaceous........................rufa

Donacia cincticornis

Egg. 5mm long, rounded at each end, the sides subparallel, slightly concave on one side and convex on the other, naked, laid in an irregular mass on aquatic plants, and attached by one end [pl.21, fig.3; pl.24, fig.3].

Larva. Mandibles bidenticulate with a few crenulations within [pl.25, fig.1]; eyes apparently wanting; all the segments of the leg with only a few setae, the basal segment with eight to 10, each of the others with three or four [pl. 25, fig.3]; the labrum four sided, emarginate in front with eight marginal setae, the two lateral ones of each side distant from the median ones and from each other, with six discal setae, the distal pair about one half the length of the median pair, the proximal pair as long as the distal and median pairs together, two lateral setae, each extending beyond the front margin of the labrum, and two sensory pits [pl.25, fig.6]; the anterior tergal setae of the mesothorax and metathorax divided into three well marked groups, those of the first six abdominal segments straight and broad and not divided, those of the seventh segment consisting of an irregular row of setae; the posterior tergal setae of the first six abdominal segments of about the same length as the anterior tergal setae, those of the seventh abdominal segment almost as long as the width between the spiracles; the supraspiracular setae of the first six abdominal segments broad[1] and well marked and coalesced with the lateral extensions of the anterior tergal setae, and not coalesced with the lateral extensions of the posterior tergal setae; those of the seventh abdominal segment consisting of three or four setae and hardly more than a continuation of the anterior tergal setae; the infraspiracular setae well marked, triangular in outline, becoming smaller caudad; the anterior and posterior sternal setae of the prothorax broad and separated, those of the mesothorax and metathorax broad and separated except at middle, the

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[1] By this expression is meant not a single setae, but the group of setae known as the supraspiracular setae, and it is used in this sense throughout.

sternal setae of the first three abdominal segments broad and not divided longitudinally, those of the fourth abdominal segment narrow and hardly continuous at middle, those of the fifth, sixth and seventh abdominal segments divided longitudinally; the pedal setae of the first three abdominal segments almost as long as the width of the segment, those of the last four segments smaller and circular in outline [pl.29, fig.1].

Pupa. Whitish; legs, wing-pads and antennae not closely attached to the body; the second and third segments of the antennae subequal; the pronotum with a distinct median furrow and without lateral tubercles; the first ventral abdominal segment as long as the next five. Length, 11mm; width, 4mm.

Cocoon. Black; oval in outline, rotund, concave on the ventral surface; and attached in groups to the apices of the large lateral stems of Nymphaea advena. Length, 13mm; width, 7mm.

Described from specimens loaned by the Museum of Comparative Zoology and collected by George Dimmock at Canobie Lake, N. H., July, 1887.

Donacia palmata

Egg. 1mm long, opaque white, both ends bluntly rounded, the sides parallel; laid in a double row, 40 or 50 eggs in a mass, the mass completely surrounded by a thick, gelatinous covering, on the under surface of the leaves of Nymphaea advena and of Castalia odorata [pl.21, figs. 1 and 4; pl. 24, fig.4].

Larva. Mandibles apically bidenticulate, the inner margins with poorly marked crenulations [pl.25, fig.11]; eyes present, four in number, three in the anterior row [pl.25, fig.10]; the segments of the legs with few setae, four or five setae to a segment [pl.25, fig.12]; the labrum four sided, with eight long marginal setae, the six outer setae much the longer and equidistant from each other, the median pair about half the length of the others, with six discal setae, the distal and median pairs near the middle of the labrum and proximad of the sensory pits, the distal pair not more than half the size of the median pair, the proximal pair distinctly longer than the median pair, the median pair more distant from each other than either the distal or proximal pairs, the two lateral setae long and slender, and with four sensory pits [pl.25, fig.9]; the anterior tergal setae of the mesothorax and metathorax and first three abdominal segments divided into three groups, those of the thoracic and first two abdominal segments widely separated, those of the other segments not so well marked, the anterior tergal setae of the first five abdominal segments attenuated laterally and indistinctly connected with the supraspiracular setae, those of the sixth and seventh segments not attenuated laterally, and distinctly separated from the supraspiracular setae, the anterior tergal setae of the seventh segment not more than one half the width of those of the other segments, the posterior tergal setae of the seventh segment broad and continuous; the supraspiracular setae of the first six abdominal segments transverse, well marked, but not extending caudad as far as the posterior tergal setae, those of the seventh abdominal segment but little broader than the band of anterior tergal setae; the infraspiracular setae broad and somewhat oblique; the anterior and posterior sternal setae of the thoracic segments distinctly separated, the posterior sternal setae of the prothorax divided longitudinally, the sternal setae of the first four abdominal segments broad and continuous, those of the fifth and sixth abdominal segments smaller and divided longitudinally, those of the seventh abdominal segment forming an almost continuous but attenuated band at middle, and coalescing at its outer ends with the pedal setae; the pedal setae of the first six abdominal segments well marked and distinct, not coalesced with the sternal setae [pl.29, fig.2].

Pupa. White; legs, wing-pads, and antennae not closely attached to the body; the third segment of the antennae almost twice the length of the second; pronotum with an indistinct median furrow and not tuberculate on the sides in front; the first ventral abdominal segment as long as the next three. Length, 11mm; width 5mm.

Cocoon. Brownish; oval in outline; and attached in groups of three or four on the leaf scars of the underground stems of Nymphaea advena. Length, 11mm; width, 5mm.

Described from numerous specimens collected by J. O. Martin and the writer on the stems of Nymphaea advena at Ithaca N. Y.

Donacia subtilis

Larva. Mandibles bidentate, the inner margins hardly crenulate [pl.25, fig.15]; eyes present, five in number, arranged in two rows [pl.25, fig.13]; the three segments of the legs with numerous large setae of varying lengths [pl.25, fig.14]; the labrum distinctly five sided, with eight marginal setae, the outer distinctly longer than the six inner, which are subequal in size and adjacent and distinctly separated from the lateral marginal setae, with six discal setae, the proximal pair long and slender, the median and distal pairs almost in a line, the median pair the longer, with two lateral setae which are as stout and as long as the proximal discal setae, and with two sensory pits [pl.25, fig.17]; the anterior tergal setae of the mesothorax and metathorax divided into three groups, those of the first six abdominal segments continuous and connected with the supraspiracular setae, those of the seventh segment continuous, but with their lateral extensions widely separated from the supraspiracular setae, the posterior tergal setae of the mesothorax distinct from all the other groups, those of the metathorax with their outer ends curving cephalad and slightly coalescing with the anterior tergal setae, those of the first five abdominal segments continuous and straight and of about the same length as the anterior tergal setae, those of the sixth abdominal segment only slightly separated from the supraspiracular setae, which in this segment extends much farther caudad than in the others, those of the seventh abdominal segment curved and extending from one spiracle to the other; the supraspiracular setae broad, well marked, those of the seventh segment small, consisting of only a few setae; the infraspiracular setae of medium size and oblique, those of the seventh segment behind the spiracle and near the apex of the posterior tergal setae; the anterior and posterior sternal setae of the thorax distinctly separated and divided longitudinally into two groups, the sternal setae of the first five abdominal segments square in outline and continuous, those of the sixth and seventh segments divided longitudinally into two groups; the pedal setae well marked and not joined to the sternal setae [pl.29, fig.3].

Pupa. White; legs, wing pads, and antennae not closely attached to the body; the second and third segments of the antennae subequal; the pronotum not with an impressed line nor tuberculate on the side in front; the first ventral abdominal segment as long as the next four. Length, 9mm; width, 5mm.

Cocoon. Brownish; oval in outline; and attached along the middle line of the leaf of a sedge. Length, 10mm; width, 5mm.

Described from numerous specimens loaned by the United States National Museum and probably collected by Messrs Hubbard and Schwarz on rushes along the Detroit and St Clair rivers in August 1873.

Donacia porosicollis

Egg. $1\frac{1}{2}$mm in length; opaque white in color; each end bluntly rounded, the sides subparallel, naked, not surrounded by a gelatinous covering; laid in a single row along the edge of the leaves of a sedge under water, and attached by one side [pl.21, fig.2; pl.24, fig.3, 4].

Larva. Mandibles distinctly medially bidentate with well marked teeth within [pl.26, fig.1]; eyes present, five in number, arranged in the form of a very irregular trapezoid [pl.26, fig.6]; all the segments of the leg with many setae [pl.26, fig.5]; labrum indistinctly five sided, with eight marginal setae, the six median ones short, subequal in length, and equidistant from each other, the lateral ones long and distant from the median ones, with six discal setae, the distal pair in front of a line drawn between the median pair and about as long as the median pair, the median pair long and stout, the proximal pair very long and slender, the distal and median pairs in front of the distal pair of sensory pits, with two lateral setae which are long and stout, and with four sensory pits [pl.26, fig.3]; the anterior tergal setae of the mesothorax and metathorax divided into three groups, those of the first five abdominal segments not divided and their lateral extensions united with their supraspiracular setae, those of the sixth and seventh abdominal segments not divided and distinctly separated from their supraspiracular setae, the posterior tergal setae of the mesothorax slightly joined with the lateral groups of the anterior tergal setae, those of all the other segments straight and distinct; the supraspiracular setae not extending on to the annulet of the posterior tergal setae, those of the seventh abdominal segment not consisting of more than three or four setae; the infraspiracular setae of the abdominal segments of medium size, oblique, those of the seventh segment not reaching cephalad as far as the spiracle; the anterior and posterior sternal setae of the thoracic segments distinctly separated, their posterior sternal setae divided longitudinally into two distinct groups; the pedal setae circular in outline and separated from the sternal setae; the sternal setae of the first five abdominal segments forming a continuous group, those of the sixth and seventh abdominal segments divided longitudinally, those of the seventh segment not consisting of more than three or four setae [pl.29, fig.4].

Cocoon. Brown; oval in outline; and attached along the middle line of the leaf of a sedge (Juncus). Length, 11mm; width, 6mm.

Described from specimens loaned by the Museum of Comparative Zoology and collected by Mr H. G. Hubbard in marshes of Detroit river, Michigan, in August 1873.

Donacia aequalis

Larva. Mandibles bidenticulate, with one or two well marked teeth within [pl.26, fig.8]; eyes apparently wanting; each segment of the leg with a number of long setae [pl.26, fig.12]; the labrum distinctly five sided, the front margin deeply emarginate with eight marginal setae, the six median setae equidistant from each other and subequal in size, the outer ones more distant and longer, with six discal setae, the distal and median pairs almost in a line and subequal in length, the proximal pair long and slender, with two lateral setae placed near to the proximal margin of the labrum, and with four sensory pits [pl.26, fig.11]; the anterior tergal setae of the mesothorax and metathorax divided into three groups, those of the first seven abdominal segments continuous but slightly broader at the middle of abdominal segments two, three and four, the posterior tergal setae continuous, those of the seventh abdominal segment extending as far as the spiracle; the supraspiracular setae of the first six abdominal segments divided transversely, the cephalic group being joined to the outer ends of the anterior tergal setae and the caudal group triangular in outline and midway between the anterior and posterior tergal setae; the infraspiracular setae almost as broad as the segment, oblique; the anterior and posterior sternal setae distinct, the posterior sternal setae of the thorax divided longitudinally, the sternal setae of the first six abdominal segments distinct and not divided longitudinally, the sternal setae of the seventh abdominal segment small and divided longitudinally into two groups, the lateral margins of the sternal setae of the first two abdominal segments slightly coalesced with the pedal setae; the pedal setae broad and well marked [pl.30, fig.1].

Pupa. White; the legs, wing pads, and antennae not closely attached to the body; the second and third segments of the antennae subequal; pronotum with a well marked median linelike grove and a prominent tubercle on each side in front; the first ventral abdominal segment as long as the next four. Length, 8mm; width, 3mm.

Cocoon. Dark brownish, oval in outline, attached to the side of the roots of Sagittaria and much wider than the roots to which they are attached. Length, 8mm; width, 4mm.

Described from specimens collected on the roots of Sagittaria latifolia and Sagittaria rigida at Ithaca N. Y.

Donacia emarginata

Larva. The mandibles with two median teeth and well marked denticulations within, the surface with two or three setae [pl.26, fig.18]; the eyes apparently wanting; the three segments of the legs with numerous setae [pl.26, fig.16]; the labrum four sided, with eight marginal setae, the six median setae adjacent, subequal in size, and at the bottom of a slight emargination, the lateral ones two or three times as long as the median ones and on the outer angles of the labrum, with six discal setae, the distal and median pairs in a line distad of the anterior pair of sensory pits, subequal in length, the proximal pair twice as long, stout, with two lateral setae, which are stout and near the middle of the lateral margin, and with four sensory pits [pl.26, fig.13]; the anterior and posterior tergal setae continuous and coalesced laterally with the supraspiracular setae; the supraspiracular setae long, extending almost the entire width of the segment; the infraspiracular setae forming a broad triangular patch, broadest on its cephalic margin and extending almost across the segment, the adjacent margins of the supraspiracular and the infraspiracular setae of the seventh abdominal segment coalesced; the anterior and the posterior sternal setae of the prothorax distinctly separated, those of the mesothorax coalesced on the median line, those of the metathorax broad and coalesced throughout their entire extent; the sternal setae of the first six abdominal segments broad and coalesced with the pedal setae, the sternal setae of the seventh abdominal segment minute in comparison with those of the other segments and separated from the pedal setae [pl.30, fig.2].

Pupa. White; the legs, antennae and wing pads not closely applied to the body; the third segment of the antennae subequal in length to the second; the pronotum not with a well marked median, impressed line and not with a tubercle on either side in front; the first ventral abdominal segment not quite as long as the next three. Length, 10mm; width, 5mm.

Cocoon. Dark brownish, oval in outline, attached to the side of the small roots of Sparganium androcladium and much wider than the roots to which they are attached. Length, 10mm; width, 6mm.

Described from numerous specimens collected by Dr J. G. Needham at Saranac Inn N. Y. on the bases of the roots of Sparganium androcladium [pl.23].

HAEMONIA

This genus contains a single American species, Haemonia nigricornis, which occurs rarely throughout the United States and Canada. The adult is quite similar in general appearance to the species of Donacia. It can be readily recognized by having the tarsus narrow, glabrous, and its apical segment very long, and the inner and the outer margins of the elytra at apex usually produced into well marked teeth.

Haemonia nigricornis

Larva. The mandibles bidenticulate, with distinct smaller teeth within, the surface with three setae [pl.27, fig.1]; the eyes present, five in number [pl.27, fig.5]; the basal segment of the leg with four or five setae and the surface densely papillate [pl.27, fig.4]; the labrum emarginate in front with four long marginal setae, the outer the longer, with four discal setae, the distal pair not much more than one half the length of the proximal pair, with two long lateral setae, and four sensory pits [pl.27, fig.2]; the anterior tergal setae of the mesothorax and the metathorax divided into three well marked groups, those of the first five abdominal segments straight and not divided, those of the fourth and fifth abdominal segments broader at middle than at the sides, those of the sixth and seventh abdominal segments straight and consisting of from four to eight setae, most of which are larger than those of the ordinary type; the posterior tergal setae of the mesothorax and metathorax and first five abdominal segments straight and of about the same length as the anterior tergal setae, those of the sixth and seventh abdominal segments similar in outline but consisting mainly of setae twice the length of those of the ordinary type, the seventh abdominal segment with about four extra setae on the front margin near the middle; the supraspiracular setae of the first five abdominal segments small and coalesced with the anterior tergal setae, those of the sixth abdominal segment distinctly separated from the anterior tergal setae, those of the seventh abdominal segment wanting; the infraspiracular setae of the first seven abdominal segments all of about the same size, small and oblique; the anterior sternal setae of the prothorax wanting, the posterior sternal setae indistinct and divided longitudinally into two groups, the anterior and posterior sternal setae of the mesothorax and metathorax indistinct and not joined, the posterior sternal setae of these segments divided longitudinally, the sternal setae of the abdomen in small groups and not divided; the pedal setae of the abdomen well marked on the anterior segments and becoming smaller on the posterior segments; the caudal margin of the seventh abdominal tergite produced into a blunt projection and constituting the apex of the abdomen [pl.30, fig.3].

Pupa. White; the legs, wing pads, and the antennae not closely attached to the body; the second and third segments of the antennae short and subequal; each shorter than either the fourth or fifth; the pronotum with a prominent depression at the middle in front, the front angles protuberant, the sides emarginate; the first ventral abdominal segment almost as long as the next four; the elytra usually with the outer angle strongly and the inner angle slightly prolonged at apex; the tarsal segments of a uniform width. Length, 7mm; width, 4mm.

Cocoon. Light brownish, oval in outline, and attached to the side of the small roots of an aquatic plant[1]; the cocoons broader than the roots. Length, 6mm; width, 3mm.

Described from specimens collected at Ithaca N. Y. by the writer and by Messrs Hubbard and Schwarz along the Detroit and St Clair rivers, Detroit Mich.

Subfamily GALERUCINAE

This subfamily includes several genera and species, a single one of which is found on the leaves of Nymphaea advena. The larvae feed on the epidermis of the leaves, and where this plant occurs they are quite abundant.

Galerucella nymphaeae

Egg. Oblong or short cylindric with smoothly, obtusely rounded ends; yellow, shining. The egg cluster consists of a small number (6 to 20) eggs placed closely side by side on end on the upper surface of a floating leaf of Nymphaea or Brasenia.

Larva. Head black; the antennae mere tubercles, three jointed; the labrum three sided, the distal and lateral margins in the form of a continuous convex curve constituting one side, the remaining sides formed by the proximal end of the labrum with an angle on the median line, the distal margin with a row of comb-like bristles attached to the ental surface, two long discal and two long lateral setae, the two groups forming a transverse line, and four marginal setae [pl.27, fig.9]; the mandibles tridentate, the two inner teeth subequal, the outer one much shorter [pl.27, fig.8]; the thorax and abdomen black above except at the sutures and with fine whitish fuscous lines dividing the black into distinct areas—there is such a line on the meson of the notum of the three thoracic segments, and a line on each abdominal segment dividing it into two parallel transverse bands, the posterior being the longer, at the end of each of these bands a quadrangular spot, and laterad of each anterior spot another subequal in size which bears the spiracle, and laterad of the spiracle a much larger spot as long as the

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[1] The European species are found on the roots of Potamogeton natans, and LeConte and Horn record the American species from Potamogeton; but by an oversight I neglected to record the name of the plant on which I found them.

width of the segment; the sternum of the thorax and abdomen pale except a spot on either side of the thorax laterad of the legs and homodynamous spots on each abdominal segment, a spot on either side mesad of the spots just described, and a median broad spot; and the last ventral abdominal segment with a well developed proleg, legs blackish except at the sutures.

Pupa. Black, except the sternum of the thorax and abdomen, the apical segment of the abdomen which is covered by the cast larval skin, the basal segments of the legs, and a median tergal line which are yellowish; the legs, wing pads, and antennae not closely joined to the body; the very young pupae are lighter in color. Length, 7mm; width, 4mm.

Described from specimens collected at Ithaca N. Y. and from Saranac Inn N. Y. by J. G. Needham.

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I am indebted to Mr J. O. Martin for assistance and many suggestions while carrying on the field work, to Mr Samuel Henshaw for the loan of the larvae and cocoons in the Museum of Comparative Zoology, to Dr L. O. Howard for the loan of the material in the United States National Museum, and to Prof. J. H. Comstock and Mr W. A. Riley for help on all parts of the work.

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DONACIA

aequalis Say

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[1] The European species are marked in this way.

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emarginata Kirby

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palmata Oliv.

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porosicollis Lacépède

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simplex[1] Fabricius

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[1] The European species are marked in this way.

Part 6

AQUATIC NEMATOCEROUS DIPTERA

BY OSKAR AUGUSTUS JOHANNSEN

In the following pages will be given an account of the life histories of a number of small flies, commonly known as black flies, (Simuliidae), mosquitos, (Culicidae), and midges, (Blepharoceridae and Chironomidae). The material on which this study is based was for the most part collected in the vicinity of Ithaca N. Y., though some of it came from Saranac Inn N. Y. and elsewhere. The larvae were collected by means of a small hand net from the ponds; or swept by means of a brush into a cloth "sag-net" from the surface of the rock on the bottom of the shallow creeks in the manner described by Professor Needham in United States National Museum bulletin 39, 1899, part O, page 5. The material thus collected was then transferred to the breeding cages. These cages for the pond-water larvae consist of small glass jars containing some water plants. For those forms that require rapidly flowing water a jar was used from which the water was drawn by means of a continuous siphon as rapidly as it entered.[1]

The material was collected during the summer of 1901, and studied during the fall of the same year in the entomological laboratory of Cornell University, under the direction of Prof. J. H. Comstock, to whom I wish to express my thanks for his advice in the preparation of this work. I also desire to acknowledge my obligation to Prof. J. G. Needham, of Lake Forest University, who suggested the work, directed its course and supplied me with material; to Professor Aldrich, of the University of Idaho, Professor Smith, of New Jersey, Professor Kellogg, of Leland Stanford Jr University and Messrs MacGillivray and Houghton for material from various localities.

The object of the paper is to give the distinctive generic and specific characters of larvae and pupae of the forms studied, tabulated in the form of keys, to enable any one having an elementary knowledge of entomology to identify members of this interesting group of insects.

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[1] See Comstock. Insect Life, p.330.

The Simuliidae are treated at greater length than the others, more material being at hand for the study of this family. In the descriptions of the wings of the adult, the nomenclature of Comstock and Needham (1898) has been followed.

The aquatic larvae of the Diptera may be distinguished from aquatic larvae of other insects by the absence of true, jointed thoracic legs; in having abdominal prolegs, or in being entirely legless; in the most degenerate forms the head is reduced and retracted within the pointed apex of the thorax, and no appendages of the imago are visible. Their pupae either have prominent prothoracic dorsal spiracles, often borne at the end of the antennaelike processes, or the pupa is formed in the hardened larval skin. The adults have but two wings, or in a few rare cases are apterous. The presence of the balancers and the absence of caudal filaments distinguish them from the males of the Coccidae. The most familiar examples are house flies and mosquitos.

The Diptera in general are divided into two suborders:

Larvae with a differentiated head; pupae free or inclosed in the larval skin; in either case the larval skin bursts for the extrication of the pupa or imago in a T-shaped opening on the back of the anterior end, or rarely in a transverse rent between the eighth and ninth abdominal rings. The imago lacks the frontal lunule and ptilinum. Examples are the gnats, midges, crane flies, horse flies, snipe flies, robber flies, etc. (Nematocera and Brachycera) .... Orthorrhapha

Larvae without differentiated head; pupae always inclosed in the hardened larval skin (forming the so called puparium); the imago always escaping from the anterior end through a circular orifice. Frontal lunule present; ptilinum usually present. Examples of this suborder are flesh and horse flies, bots, drone flies, etc. Among these are but few having aquatic larvae—a few Syrphidae, some of the Sciomyzidae[1] and other Acalyptrate Muscids.... Cyclorrhapha

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[1] See N. Y. State Mus. Bul. 47. 1901. p.577.

KEY TO FAMILIES OF NEMATOCEROUS DIPTERA

Larvae

1 Mandibles opposed, with the jaws moving in a horizontal plane; when the mouth parts are rudimentary, the larva has 13 segments and is peripneustic[1] (2).............Nematocera

Mandibles parallel, their motion in a vertical plane; if the motion is obliquely inward, then the head is not sharply differentiated from the first thoracic segment ....Brachycera

2 Larva with fully differentiated head, nonretractile, which contains the first ganglion and sometimes the eyes, peripneustic or amphipneustic,[2] with breathing tube or tracheal gills............(3).......Tribe Eucephala

Larva with only a "jaw capsule" (Kiefer kapsel)..........................(14)

3 Terrestrial forms, living in the earth, in rubbish, under bark, or in fungi....(4)

Aquatic or semiaquatic...............(6)

4 Larvae without thoracic prolegs.......(5)

With thoracic prolegs. Living under bark...........Ceratopogon

5 Body bristly; head usually with eyes..................Bibionidae

Body not bristly, head usually without eyes ....Mycetophilidae

6 Prolegs at least on fourth and fifth segments (i. e. on first two abdominals) (7)

No prolegs on these segments.........(8)

7 Spiracles on the first and last segments, with tracheal gills, and a very long membranous breathing tube.................Ptychopterinae

No long respiratory tube; larva swimming in a U-shape..Dixidae

8 Body flattened, onisciform, and usually with suckers underneath............(9)

Body more or less cylindric, without suckers on the intermediate segments...(10)

9 The segments alternating small and large, the outline of the body, serrate. Living in rapid flowing streams.................Blepharoceridae

The segments gradually larger at the middle of the body, becoming smaller again toward the posterior end...................Psychodidae

10 With thoracic prolegs................(13)

Without thoracic prolegs.............(11)

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[1] Spiracles confined to the median segments. The Chironomidae usually have jaws which move in oblique planes.

[2] Spiracles confined to the first and last segments.

11 Thorax enlarged; abdomen usually with long hairs; usually a complex respiratory apparatus at the anal end........................Culicidae

Body much elongated................(12)

12 Last segment of the abdomen with two fleshy points..Rhyphidae

Last segment tapering, often with a few long hairs. Body snakelike, segments of nearly uniform length. (Ceratopogon)..........Chironomidae

13 With anal prolegs and blood gills. (Chironomus, Tanypus, etc.)........................Chironomidae

Without anal prolegs; a broad abdomen, with a terminal sucker; head with a pair of fanlike organs (black flies)..................Simuliidae

14 With rudimentary mouth parts; body with 13 segments; peripneustic (i. e. spiracles on the median segments). Gall gnats..........Cecidomyiidae

With biting jaws. Head incomplete, small, retractile, not containing nerve ganglia; 12 body segments; posterior stigmata usually with some fleshy filaments (crane flies)..................................Tipulidae

Pupae

1 Prothoracic spiracles, if present, borne on appendages (Nematocera)...........(2)

Prothoracic spiracles sessile..........................Brachycera

2 Nonaquatic. Leaf miners or gall makers (Cecidomyiidae); larvae living in fungi (Mycetophilidae); larvae living in the earth (Bibionidae); larvae living under bark (some Ceratopogon)

Aquatic or semiaquatic...............(3)

3 Pupae in a fibrous cocoon..............(4)

Without cocoon, sometimes in the old larval tube..............................(5)

4 Cocoon cornucopialike, the coarse thoracic filaments of the pupa projecting. These filaments are usually few in number................Simuliidae

Thoracic filaments of the pupa if present, entirely within the cocoon, the latter usually subcylindric.....................Some Chironomidae

5 Body convex, hard shelled, and attached limpetlike to the rock...............(6)

Not attached nor limpetlike...........(7)

6 Shield-shaped, flattened. Thoracic breathing tubes are subcylindric[1]................Some Psychodidae

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[1] See Professor Kellogg's paper in *Ent. News*, Feb. 1901.

Convex, oval; breathing tubes composed of several lamellae........................Blepharoceridae
7 Prothoracic respiratory appendages simple, slender, antennaelike; pupa sluggish or motionless..................(8)
Prothoracic appendages short and pointed, or club shaped, or composed of numerous fine filaments, or entirely wanting ....(9)
8 First abdominal segment about as long as those following it........................Some Psychodidae
First abdominal segment about half as long as those following it..............................Tipulidae
9 Prothoracic appendages short and pointed.............Rhyphidae
These appendages not as above......(10)
10 With two rounded paddlelike appendages at the caudal end.[1] Pupa active.....................Culicidae
Without distinct paddles (if present, then pointed, and with ciliate margin)...(11)
11 The caudal end with two pointed processes and usually bent forward over the pectus; the pupa resting on its side.................Dixidae
Prothoracic appendages either many branched, simple or apparently wanting, the pupa in the larval tube (Chironomus) or active, Culexlike (Tanypus); or floating nearly motionless (Ceratopogon) ....Chironomidae

The above keys are modifications of those given by Mr C. A. Hart, Illinois State Lab. Nat. Hist. Bul. 1895. v.4, art.6, p.186-89.

To determine the imagines, the reader is referred to Comstock's *Manual for the Study of Insects*, or to Williston's *Manual of the North American Diptera.*

Family BLEPHAROCERIDAE

Net-winged midges

These flies are of moderate size, elongate and bare, with long legs and broad wings. The ocelli are present; the proboscis is elongated; the antennae are slender, composed of from six to 16 joints, clothed with short pubescence. The thorax has a distinct though interrupted suture. The empodium is very small and the pulvilli are wanting. The wings are broad, without hair, with a projecting anal angle; characterized by a network of fine lines which extend in various directions and not influenced by the veins of the wing, though apparently constant in position in a given species.

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[1] Corethrella (q. v.) is an exception: having two pointed caudal lobes.

The larvae live in running water. The head has a pair of slender antennae; the cephalothorax and the following segments each with a conical process bearing a bunch of bristles; pupa flattened, inactive and free, inclosed in a semioval shell-like skin, the anterior end with erect breathing tubes; on the underside the skin is soft and transparent.

Genus BLEPHAROCERA Macq.

This genus is distinguished from the other genera of this family, in that the eyes are holoptic (i. e. contiguous); bisected by an unfaceted cross band or by a single groove. The radius (Comst.) is three branched (i. e. the second longitudinal vein is not furcate); and the vein M_3 with its basal end free and beginning in the middle of the wing. See figure in Comstock's *Manual,* p. 433.

Blepharocera capitata Loew

Berl. Ent. Zeit. 1863. Centur. 4; p.43

So far, but one species of this family, Blepharocera capitata Loew, has been recorded from this State. It is very abundant in several of the ravines about Ithaca, and larvae have been found in other parts of the State. The first adults observed the past year, emerged about June 1, and they had all disappeared by July 15. The fact that their season of flight is a short one, and that they are found only near the water's edge in deep and comparatively inaccessible ravines, accounts for the scarcity of the species in collections. The life history of this species has already been given by Prof V. L. Kellogg in *Entomological News* for January 1900, p.305-18; and the imago has been described by Loew in the *Berliner Entomologische Zeitschrift*, 1863, p.43. The life history may be briefly stated as follows:

The eggs have not yet been discovered. The larvae may be found throughout the month of May, in shallow but swiftly flowing water. About Ithaca they have been found most frequently in the little stream flowing through Coy glen, in Six Mile creek, and in Cascadilla creek; and have also been collected by Mr A. D. MacGillivray in a brook near Axton N. Y. During the early part of May the larvae are still quite small, the smallest found measured 2.5mm in length, and were scattered over the smooth rock bed of the stream where the water is swift, but only about 1 inch in depth. If removed from the brook and placed in vials or still water, they soon die, usually within a few hours.

The larva is a curious black creature, flattened, its length being about two and one half times its breadth at widest part, each of the four intermediate segments separated from each other and from the cephalic and anal portion by deep constrictions, thus dividing it into six distinct parts. Kellogg says (in the paper just quoted) that the anterior, apparently single segment is composed of the fused head and three thoracic segments, while the most posterior part is composed of the last two abdominal segments, the intervening parts representing each a single abdominal segment. The larva is footless, but each body part bears a pair of small unsegmented, pointed projections, situated on the ventral aspect of the lateral margins. The organs of locomotion consist of six suckers, one of which lies on the median ventral aspect of each body part; thus there is but one sucker for the combined head and thorax, and but one for the last two abdominal segments. By means of these suckers, the larva clings to the rock bed of the stream. The larva occasionally moves about on the smooth surface of the rock, from the necessity of getting farther into the stream as the water lessens in quantity, and perhaps also, for seeking its food—the diatoms on the surface of the rock. The structure of the sucker is well described by Kellogg (*loc. cit.*). The larvae breathe by means of small tufts of short thick tracheal gills, of which there is a pair on the ventral surface of each of the first to the fifth abdominal segments. On the last segment there are two pairs of much larger, thicker, fingerlike processes, perhaps also tracheal gills. The writer collected during May many living larvae, and attempted to rear them, by placing them in aquaria of running water, but succeeded with only four specimens. The first of these cast its larval skin on May 20; the second on the 25th, the third on the 26th, and the fourth on the 27th. The casting of the larval skin is most rapidly accomplished. A larva in the breeding cage attracted attention because of its grayish color, not so black as usual, the pale color owing, probably, to the skin being loosened. A moment later, perhaps half a minute, the empty larval skin was seen floating away, leaving the cream-white pupa on precisely the same spot which had been occupied but a moment before by the larva. In the new pupa, the constrictions of the body so distinctive in the larva, were still plainly visible; within half an hour they began to disappear, and the color gradually became darker. In from three to four hours the pupa had assumed its characteristic shape, and the coal-black color. The four empty larval skins examined, all had a small irregular break on the ventral surface just cephalad of the first sucker, and another small T-shaped opening on the dorsal surface opposite the one on the ventral. The rest of the skin, including the suckers, remained intact.

The pupa is coal-black, heavily chitinized, and is shaped like the half of a longitudinally cut egg, though somewhat more flattened. At the anterior end is a pair of dorsal, prothoracic tracheal gills, each gill consisting of four flattened plates. The whole of the flat ventral surface of the pupa is fastened so firmly to the rock that it is practically impossible to remove it without breaking the shell. The length of pupal life is from 16½ to 18 days. If the pupae be taken from the water on the piece of rock to which they are attached, removed to the aquaria, and placed with the heads down stream, under a small stream of water, no difficulty will be experienced in rearing them. A number of specimens reared in this way were observed by the writer to emerge. From five to 15 minutes are required for the imago to free its body from the pupal skin, the wings remaining folded till the abdomen is free, when suddenly they spread out fanlike and held above the surface of the shallow water, the legs all bunched up and still remaining in the pupal skin. The force of the flowing water and the struggles of the insect in from one to five minutes cause the legs to draw out, and, thus liberated, the imago immediately takes flight. In deeper water the wings probably do not unfold till after the insect is washed to the surface, though no observations were made upon this. Figures of larvae and pupae may be found in Comstock's *Manual*, and in Kellogg's papers in the *Entomological News* for 1900, and in Cal. Ac. Soc. Proc. 1903.

Family SIMULIIDAE

Black flies

In this family the body is short and stout; the legs are short; and the tibiae possess spurs. The antennae are scarcely longer than the head, cylindric and 10 jointed; the two basal joints are differentiated; the others are closely united. Proboscis not elongated, with small horny labella; palpi are four jointed. The thorax is much arched, giving the fly a humpbacked appearance; the scutellum is small; the abdomen is cylindric, composed of seven or eight segments; the legs strong and not elongate. The wings are broad, iridescent, and not clothed with hairs. The veins near the costal border are stout; those on the other parts of the wing are very weak. [*See* pl.34, fig. 1]

The larvae are soft skinned, not slender, usually more or less constricted in the middle. The head is cylindric, with eye spots on each side. The head bears two large fan-shaped organs, which aid in procuring the food. Respiration is accomplished by means of three blood gills which are pushed out from the dorsal surface of the last abdominal segment (Miall & Hammond say from the rectum). On the segment back of the head is a foot armed with hooks, and on the posterior end of the body is a disklike sucker by means of which the larva clings to the rocks or to plants. The creature moves about on the surface of the rocks with a looping gait similar to that of a measuring worm, and a web is secreted which prevents its being washed away by the swiftly flowing water.

The pupae are incased in cocoons which are firmly fixed to the rocks, these cocoons sometimes occurring in dense masses, forming a carpetlike covering on the rocks; in other species they occur separately or in small groups. The pupae, like the larvae, breathe by tracheal gills; but in this stage the gills are borne by the prothorax. The adult fly, on emerging from the pupa skin, rises to the surface of the water and takes flight at once. Soon after this the eggs are laid.

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The life histories of some of the members of this family have long been known. Otto Fabricius in 1784[1] published an article, "Beschreibung der Atlasmücke und ihrer Puppe." A little later (1795) Schönbauer published his account of the immature stages of the Columbacz midge. He was the first to state that these earlier stages are passed in the water. In 1822 appeared Verdat's paper, on Simulium sericeum (=S. reptans, according to Schiner) in which he figures the pupa, the larva, together with enlarged details of the mouth parts of the latter. Among other early writings on life history may be mentioned Fries's monograph, *Simuliar* (1824), Westwood's *The Water Cress Fly* (1848) and Heeger's *S. columbaschense* (1848). More recently there appeared in proceedings of the Royal Society of Copenhagen (1886) a very useful paper by Fr. Meinert on "De eucephale Myggelarver," of which six or seven pages are devoted to Simulium, besides some very good figures. On the early stages of American species, Riley, in the report of the United States entomologist for 1884, p. 342-43, writes as follows:

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[1] Schr. d. Berl. Ges. naturf. Fr. 5:254–59, tab.3, fig.1–5.

> The early stages of several of the American species have been studied. In the *American Entomologist* [June 1870, 2:227] under the heading, "The Death Web of a Young Trout" we described the larva and pupa with figures of a species afterward described by us as Simulium piscicidium [*ibid*, p. 367]. These larvae were said by Seth Green to live attached to stones in swift running water and to spin a silken thread in which young fish became entangled and killed. This statement created much excitement among fish culturists at the time, and really seemed very plausible. It was contradicted, however, by Sara J. McBride, of Mumford N. Y., in an article published in the same volume [p.365-67], and also by Fred Mather of Honeoye Falls N. Y., in private correspondence with us. Mrs McBride found that the perfect flies issued about April 1, and June 1 thereafter the larvae were found in the streams in great numbers—as a general rule attached to water plants 3 or 4 inches below the surface of the water. Some were also attached to stones at the bottom. The majority were fastened to green decaying water cress, and these were green in color, while others which held to dead forest leaves of the previous year's growth, which had become entangled in the cress, were brown. From this fact she justly argued that they fed on decaying vegetable matter. There was a succession of generations or broods throughout the season, the development of a single brood occupying about two months. The flies issuing in midsummer were smaller than those developed in the spring and fall, although no difference in the size of larvae and pupae was perceptible. In the same volume (229–30), Osten Sacken gives an account of an undetermined species found attached to the roots and plants in swift running streams in the vicinity of Washington. This article contains also an able review of previous writings on the subject and is illustrated with figures taken from Verdat. In the *American Entomologist* [Aug. 1880, 3:191–93] Dr W. S. Barnard described the stages, with figures of the eggs, of a common species in the mountain streams around Ithaca N. Y. The eggs

were found on the rocks on the bank a few inches above the surface of the water; the newly hatched larvae were just at the surface, and from this point there was a regular gradation in the size of the larvae down into the stream. The eggs were found abundantly on June 1. In the proceedings of the Boston Society of Natural History for January 1880, Dr Hagen described Simulium pictipes, a remarkably large species, the larvae and pupae of which were found in the rapids of the Ausable river, Adirondack mountains; and in mentioning the fact in the *American Naturalist* for April 1881, we stated that the larvae and pupae of presumably the same species were found by Messrs Hubbard and Schwarz in the rapids of Michipicoten river, north shore of Lake Superior. The larvae were there found to have the peculiarity of floating in long strings, attached to each other by silken threads, while the pupae, found in the quieter pools close by, resembled coral. We also hazarded the statement that these were the immature forms of the celebrated black fly of the Lake Superior region. In reference to the probable identity of the Adirondack with the Lake Superior species, Dr Hagen, in comparison of the specimens of these larvae and pupae, received from Mr Hubbard, with similar stages of S. pictipes, remarked [*Canadian Entomologist*, 13:150–51] that, while the larvae and pupae did not differ materially, imagos from the Lake Superior, not raised from the pupae collected by Mr Hubbard, differed from S. pictipes in the much smaller size and in the color of the legs.

The report of the United States entomologist for 1886 contains detailed account of the life history of two species, the southern buffalo gnat and the turkey gnat. This paper is the most complete record we have of any species of Simulium in this country.

Economic importance. In the northern states the attacks of the black flies on domestic animals, though causing considerable loss to the stock raiser, is not of such a nature that accurate statistics can be obtained. Otto Lugger, late state entomologist of Minnesota, in his report of 1896, p. 201 and 203, says:

> The losses caused by this insect are, in some years, very great, and the state of Tennessee alone lost in 1874 as much as $500,000. This southern buffalo gnat occurs as far north as Minneapolis, at least a few specimens have been found there. Here in Minnesota we have a number of other species of this family of flies, which cause more or less injury to our stock.

The first species seen and felt occurs early in the spring, soon after the snow disappears. It is a very small species, which flies with great force so that it can be felt when striking the face. It seems that it does not care much for human blood, but it irritates considerably by being of a very inquisitive nature, even entering the mouth, nose, ear and what is worse, the eye. If horses are left standing for some time in the roads, they are apt to become restive, shake their heads in a violent manner, frequently stamping and snorting at the same time. If the ears of the horse are inspected, we usually find the cause of their irritation in a large number of such small flies, which are busily engaged in sucking the blood, and they do so by inserting their powerful piercing organs into a vein, hence they seem to be arranged in regular rows. If not occuring in very great numbers, they cause but little harm, and an application of a little grease rubbed together with a few drops of carbolic acid, soon remedies the evil, and drives away other intruders. This species flies from May 15 to June 1, and very likely breeds in the Mississippi river near Minneapolis, though the earlier stages have, as yet, not been found. A little later in the season, but chiefly during June and July, a somewhat larger species (Simulium decorum Walker) becomes numerous. This species occurs sometimes in large numbers, but only females have been found thus far. This is of course easily explained by the fact that only the females of these flies are bloodthirsty; the males remain near the place of their birth, some running water, and, as they have only a rudimentary mouth, they could not imbibe blood, even if they were inclined to do so. This fly attacks, by preference, cows, and is sometimes found in such large numbers as to cause some injury to them. They are found most usually in the ears, and between the legs, or wherever the skin of the animal is thin and not well protected with hairs. Sometimes the cows suffer severely from their attacks, and, being constantly irritated by these small tormentors, they lose in flesh and give less milk. The front feet are in constant motion, a habit all species have, and are utilized more as feelers than as legs. This species is found active during the whole summer and autumn, but only in certain places, which can however be very far from the breeding places, and these insects must possess some very powerful sense to detect their victims such long distances.

The damage done in the South is described by Riley as follows:

As far as can be learned the damage in Louisiana was but slight prior to 1850; but many animals were killed in 1861, 1862, 1863, 1864 and 1866. In this latter year the parish of Tallulah La. lost over 200 head of mules, and upward of 400 mules and horses were killed within a few days in the parishes of Madison, Tensas, and Concordia, all in the same state. In other states they also did great damage. In 1868 many mules were killed in the lowlands of Davies county, Ky. Although frequently causing more or less trouble and loss, they did not appear again in such overwhelming numbers until 1872, 1873, 1874, 1881, 1882, 1884, 1885 and 1886. In 1872 it was reported that the loss of mules and horses in Crittenden county, Ark., exceeded the loss from all diseases. In 1873 they caused serious injury in many parishes in Louisiana. In 1874 the loss occasioned in one county in southwest Tennessee was estimated at $500,000. The gnats have been especially injurious since the Mississippi floods of 1881, and 1882; in the latter year they were more destructive to stock than ever before, appearing in immense numbers in eastern Kansas, western Tennessee and western Mississippi, and the great destruction of cattle, horses and mules caused by them added greatly to the distress of the inhabitants of these sections of the country caused by unprecedented floods. Many localities along the Mississippi river in Arkansas also suffered severely. In 1884 buffalo gnats appeared again in great numbers and were fully as destructive as in 1882. In Franklin parish, La., within a week of their first appearance, they had caused the death of 300 head of stock. They were equally numerous throughout the whole region infested, and for the first time in the history of the pest they attacked horses and mules on the streets of the cities of Vicksburg and Memphis. No general outbreak took place in 1885, yet gnats appeared in sufficient numbers to kill quite a number of mules in various parishes of Louisiana, especially in Tensas and Franklin. Buffalo gnats appeared again in immense numbers in 1886, and extended throughout the entire lower Mississippi valley, and swarms were even observed and doing damage far away from the region usually invaded. They came very late in the season, and consequently animals were in better condition to withstand their attacks. The damage was great however in many localities where planters had not taken steps to protect their stock. Besides the actual loss by death to their stock, planters lose much valuable time in preparing their fields for the crops. It so happens that the gnats appear at a time when the ground becomes fit to be prepared for cotton, and, as it is very important to give that plant as much time as possible to mature, every day is very valuable in early spring. Planters owning large estates have to use their mules for plowing, notwithstanding the gnats, while farmers on a small scale can keep their animals in the stable, thus protecting them.[1]

Remedies and preventives

A number of remedies to counteract the poison of the buffalo gnats have been tried, but none of them have been sufficiently tested or have proved uniformly effective. The following applications have been of sufficient use to merit further trial: (1) Rubbing with water of ammonia, and administering internally a mixture of 40 to 50 grains of carbonate of ammonia to 1 pint of whisky, repeating the dose every three or four hours until relieved; (2) continued doses of whisky alone and keeping the animal in a cool and darkened stable; (3) immersion in cold water in running streams. Many cases of death of human beings from the bites of buffalo gnats have been reported, and some of them seem well authenticated. The painfulness of their attacks will certainly put people on their guard, but it would be well for persons in localities subject to their invasion to go prepared with some means of protecting themselves when far from shelter during the season of the year when the flies abound. The adults have so far appeared but little subject to attack from other animals. But few birds have been observed to feed upon them, though for the Southern forms the mocking bird, winter wren, and especially barnyard fowls, after the flies become gorged with blood feed upon them. Dragon flies, Libellulidae and robber flies, Asilidae, have been observed to catch them. The larvae are devoured in large numbers by the smaller fishes, minnows, etc., and probably the carnivorous beetle, bugs and other aquatic insects prey upon them. Dr Howard has observed in Washington the larvae of a species of Hydropsyche feeding upon the larvae of a species common in that locality. The pupae are pretty well protected by the resemblance in color to the objects to which they are fastened and their quiet habits. The eggs would seem to be open to the attacks of fishes, carnivorous beetles, etc., but no positive observations have been made. *Osborn*[2]

Very little can be done to destroy this insect in its earlier stages. The removal of obstructions in the rivers, which cause an acceleration of the motion of the water, would destroy some of their breeding places, but when there are so many this would make but little difference. Any chemicals to kill the larvae and pupae in the water would also kill fish, as they would have to be used very strong. The only way we have to protect ourselves and our animals are repelling substances, such as stinking oils and smudges. A number of repellents are sold, and some of them are very good, for instance the "Black-fly cream," made in Portland Me. Our fishermen and hunters frequently use a mixture of kerosene oil and mutton tallow, with which the exposed parts are greased. For animals any of the strong smelling oils can be used, but repeated applications are apt to hurt them or to remove the hair. Oil of tar is a simple and easily applied wash. To make it, a quantity of coal tar is placed in a large shallow receptacle in which is stirred a small quantity of oil of tar, or oil of turpentine, or any similar material. After filling the receptacle with water it is kept undisturbed for several days, when the animals to be protected are washed with the impregnated water whenever necessary. Smudges are the best as a protection and the animals soon realize their protection and crowd to them for shelter, even refusing to leave them when needed elsewhere. As the black flies are active during the day only, and the mosquitos towards evening and night, dwellers in our northern woods have a bad time of it and sometimes suffer very greatly on their account. It is easy, however, to drive these tormenters from houses or tents. By burning inside of them a little Pyrethrum powder (Persian or Dalmatian insect powder) upon a piece of bark these intruders are either killed or so stupefied that they do not bite for some time. This method is in general use in the houses and stores of the Hudson Bay Company, and the writer has always used it successfully in his numerous trips. The fumes of the burning insect powder are not very offensive, at least not nearly so much so as the poisonous bites of such insects as black flies and mosquitos. *Lugger*[1]

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[1] U. S. Dep't Agric. Rep't. 1886. p.502.
[2] U. S. Dep't Agric. Div. Ent. 1896. Bul. 5, n. s. p.37, 38.

Structural characters

There is but one genus of the family Simuliidae, Simulium, which possesses the characters of the family.

The eggs of the known species are deposited in a compact layer on the surface of rock over which water is flowing in situations as shown on plate 32. Their shape is elongate ellipsoidal, but they are usually closely packed with the long axis vertical and hence assume a polyhedral cross section. Eggs of the different species doubtless vary in size, those of the larger species (e. g. S. pictipes) measuring .40 by .18mm. In

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[1] Minn. Agric. Exp. Sta. 1896. Bul. 48, p.207.

Hungary the eggs of S. columbatczense midge have also been studied. When first laid, they are enveloped in a yellowish white slime, which becomes darker, till, finally, it becomes black just before the emerging of the larva; the egg stage lasting about a week. For further notes on the eggs of Simulium see New York State Museum bulletin 47, 1901, page 408.

Larva. The larval stage of the known species lasts about four weeks in the summer, though longer in the cold weather. It is in this stage that it hibernates. Swift flowing water is essential to its life; if removed to quiet water, it dies within a day, and usually in a few hours. Fastened to the rock, twig or leaf by the anal end of the body, it assumes a more or less erect position and moves its head occasionally with a circling motion. It is able to move about on the surface of the rock or sides of the vessel in which it may be placed. Its manner of progression resembles that of the larva of a geometer moth, though not so rapid. Attaching itself by means of its thoracic proleg, it draws up its body in a loop, then, attaching itself by means of its caudal sucker, it releases the hold of its proleg. According to the unpublished observations of Miss R. Phillips (of the class of 1890, Cornell University), the larva feeds on algae, as Nothix, Cladophora, Vaucheria, on diatoms and parts of phanerogamous plants. Sand also has been found in the digestive canal.

Structure of the larva. The full grown larva of even the largest species does not exceed 15mm (about ⅝ inch) in length. The body is somewhat cylindric in shape, enlarged at both ends, attenuated in the middle, the posterior half much stouter than the anterior part, and almost club-shaped [pl.34, fig.9]. Besides the head there are 12 poorly defined segments, the first two of which consolidate shortly before pupation. The color of the larva varies with the species, and perhaps also, to some extent, with the nature of its food. Some are a deep shining black, with paler incisures; others gray, yellow or dark green; in some the ventral surface is much lighter than the dorsal, and in most of them the incisures are paler in color. On each side of the thorax is a triangular dark spot in the mature larva which marks the position of the developing tracheal gills of the pupa. The head is nearly quadrangular, a little longer than wide, dark brown or blackish in color, heavily chitinized, with two approximated irregular black eye spots on each side near the lateral margin.

The antennae are placed at the sides of the head toward the cephalic end, dorsad of and near the base of the fan. They are very slender, apparently three jointed, about one half as long as the width of the head. The first joint is twice as long as the others taken together, slender, flattened, and sometimes almost hyaline; cylindric at the articulation with the second. The second joint is very slender, cylindric. The third joint is a short pointed process at the apex of the second; and two similar processes are usually to be seen at the articulation of the first and second. The fans are placed laterally at the cephalic end of the head [pl.34, fig.7]. Each fan consists of from 30 to 60 scythe-shaped rays (variable with the species), ciliate on the inner side, with longer setae at regular intervals [pl.34, fig.7, 8]. Each ray is widened dorsoventrally on about its basal one fourth, and, when spread, presents the appearance of the arc of a circle extending over the width of the fan near the base. The rays of the fan are borne on stout peduncles, to which they are articulated. The fans seem to be used in sweeping food into the mouth of the larva. When closed, the tips of the rays come just to the oral opening. The rays are folded when the larva is disturbed, otherwise widespread. The mandibles are placed ventrad of the fans and move in a horizontal plane. They are elongate, rather stout, brown, nearly twice as long as wide, furnished with teeth on the inner side near the apex, from two to four large, black teeth at the apex, and from six to 15 paler colored teeth behind these, gradually decreasing in size, excepting that the last two are usually stouter and larger than those immediately preceding. The stout apical teeth are difficult to count because, lying in different planes and covered by the hair, they are somewhat obscured. The mandible is furnished with a dense fringe of hairs extending over its apex, more or less overhanging the teeth. Near the base on the ventral side (the jaws moving in a horizontal plane) is a fan of hairs which projects mesad, at right angles to the long axis of the mandible. Ventrad and mesad of the mandible are the maxillae. The maxilla with its palpus projecting outwardly is shaped somewhat like a mitten, the palpus representing the thumb [pl.36, fig.2]. Several long fringes of hairs extending cephalad and mesad, cover the surface of the lacinia, among which is a single stout spurlike process. On the palpus are a few scattered bristles, at its base usually a small tuft of hairs, and its apex is provided with papillae. The chitinous labrum is a short, somewhat semicircular shaped piece overhanging the mouth, its plane being nearly perpendicular to the long axis of the larva. Externally it is stiffened by a T or Y shaped brace, the stem forming a longitudinal keel [pl.33, fig.11, and pl.36, fig.5]. Extending apically is a long fringe of hairs, and back of the suture, combed backward and outward. are long hairs. The apical margin is sometimes serrate. The hypopharynx, through which the silk thread passes, is a rather complex structure; it consists primarily of two flattened chitinized plates, connected by membrane, forming a flattened tube [pl.37, fig.2]. At the apical (cephalic) end of this is articulated a complex chitinous doubly arched segment with two fringes of long, coarse hairs. The ventral plate is somewhat quadrangular in shape, widened cephalad, with its anterior and posterior margins concave, and its lateral margins sinuous. On its anterior margin, apically, is a transverse chitinous comb [pl.36, fig.4]. The dorsal plate [pl.37, fig.2] is composed of two triangular pieces joined on the center line. On its apical (cephalic) edge is a transverse comb which projects cephalad and ventrad. This comb lies somewhat cephalad of the comb of the ventral plate. The dotted lines of plate 36, figure 4, mark the position of the dorsal plate. The ducts from the silk glands [pl.37, fig.2] pass up between the two plates, the threads uniting as they pass between the combs of the dorsal and ventral plates. I believe the function of the upper plate to be a press for the silk thread. On each side, extending dorsad and caudad, is a chitinized, hornlike process. Only the fringe of hairs of the hypopharynx is visible when the larva is viewed from below, the rest being covered by the labium. The suture between the labium and the ventral surface of the head, indistinct in some species, seems entirely wanting in others, and therefore, the labium is immovable. The cephalic margin of the labium is furnished with regularly placed teeth; the arrangement of which, together with the number and arrangement of the setae on the ventral surface, furnishes some excellent specific characters. Since, in order to identify a species, it is necessary to dissect out the mouth parts, a few words in this connection will not be out of place here. If the specimen, either fresh or alcoholic, be placed on its side, and with a scalpel a frontal cut made through the head, passing just below the eye spots separating the dorsal from the ventral surface, then, placing the sections with the cut surface uppermost, the mouth parts may be readily picked out with a needle. In the ventral part will be found the maxillae, the hypopharynx and the labium. The hypopharynx lies very close to the labium and therefore requires some care to remove it. In the dorsal part will be found the fans, the labrum, and the mandibles. If the cut be made too far toward the dorsal surface, the mandibles will be attached to the ventral part, and the labrum will probably be destroyed, since it lies at right angles to the axis of the body, overhanging the mouth opening. The separate parts may then be dehydrated, cleared, and mounted on a glass slide.

The single thoracic proleg attached to the ventral surface of the first (or second?) segment is an elongate, truncate, conical process, at its extremity with a number of rows of hooks, similar to those found at the anal end, to be described later. The use of this proleg has already been mentioned. From a narrow, slitlike opening on the dorsal surface of the last segment of the body are projected the retractile, translucent, respiratory filaments (blood gills). These are three branched, sometimes simple, often much lobed [pl.37, fig.9]. Caudad of these is a chitinized, X-shaped fold, the anterior branches extending cephalad and laterad for a short distance. At the caudal end, with its plane nearly at right angles to the longitudinal axis of the body, are concentric circles of tiny hooks, the center of the circle being hollowed out, suckerlike. The rows of hooks, though arranged in concentric circles, are also arranged radially, so that about 100 radii may be counted, each radius with from eight to 20 hooks (varying with the species, and perhaps also, with the age). The function of these hooks with the suckerlike disk is for attaching the larva to the rock or rubbish in the water, affording a very firm hold. In some species the circle is not quite complete, but is slightly open on the dorsal side. The larva possesses two silk glands, laterally placed, extending about three fourths the length of the body, then recurved, U-shaped, extending back to the thoracic segments. The outlets are the two ducts which lead into the hypopharynx [pl.37, fig.2]. The silk is used by the larva for attaching itself to the surface on which it rests, to prevent its being washed away by the rapid flowing water and to build its pupal case. According to observations made by Miss Phillips and recorded in her thesis (1890), the spinning of the cocoon of S. pictipes is described as follows:

"In spinning, the thread issues from the mouth and is placed in the different positions by the thoracic proleg. The head is bent down, and with the proleg the thread is drawn around the body and other threads placed or twisted in all directions, until a very irregular network is formed, covering the whole of the body, except the head. The skin of the head is then cast off, and the insect pulls itself out of the skin of the body, leaving it whole. The cast skin may often be found in the cocoon, with the pupa. The cocoons are commenced at the upper margin and spun continuously down to the caudal end, where several threads are drawn from the cocoon and attached to the last one or two of the body segments of the pupa. The threads hold the pupa very firmly and are always found when the pupa is pulled out of its case. Spinning is rarely seen excepting when the insect is in a stream of running water."

The pupal cases are usually composed of a rough, tough, clothlike fabric, and vary in shape with the different species. Three types of cases are known to me. One is shaped like a shoe, entirely concealing the pupa [pl.35, fig.5]. This is sometimes slightly modified, the heel being less prominent, and the instep disappearing, i. e. shaped like a flattened cylinder, the planes of the bases being parallel, but oblique (S. pictipes, and in a California species). Another, the most common type, is like that of a wall pocket, the head and the thoracic filaments projecting.[1] The third type is structureless, composed of a matted mass of thread on the rock, sometimes only partly covering the pupa; as in S. hirtipes. Large numbers of pupal cases are frequently found matted together, carpetlike. The pupa are generally of a pale or golden brown color, the abdomen being somewhat darker. The eyes of the adult soon become visible, as also the legs and wing cases. Eight body segments are visible from the dorsal surface, not counting the anal. The respiratory filaments arise from a single stalk on each side; this stalk has a variable number of branches, which again subdivide into twigs. The number of twigs is constant for a given species, ranging from four (in a European species) to upward of 60 in one of our own. For a description of their structure see a paper by Dr Volger, *Die Tracheen Kiemen der Simulien Puppen.*

On the segments are a number of small, regularly arranged black hooks, by which the pupa is attached to the fibers of its case. The arrangement of these hooks appears to be uniform for a given species. The pupal stage lasts about a week, sometimes a little longer. The adult makes its escape from the pupal skin through a longitudinal rent on the dorsum of the thorax, leaving the skin, together with the respiratory filaments, otherwise intact.

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[1] See Riley's figure of pupal case in U. S. Dep't Agric. An. Rep't 1886, of S. meridionale, or U. S. Dep't Agric. Div. Ent. Bul. 5, n. s. 1896. p.53.

The generic characters of the imagos have already been given in sufficient detail in the characters of the family; to which need only be added that the tarsal claws of the male in all the species I have examined are trifid; those of the female being either simple or bifid. All the tibiae are provided with spurs, in a few species only are those of the fore legs rudimentary. The middle and hind metatarsi possess a more or less regular row of spines on the extensor margin, which are wanting on the fore metatarsi. On the second joint of the hind metatarsus at its articulation with the first, there is usually a leaflike appendage covering the base of the flexor surface [pl.38, fig. 1, 8, 9].

List of the North American species of Simuliidae, genus Simulium

Latreille, Hist. Nat. Crust. et Ins. 1804. 14:294.

[1]***argus** Williston, N. Am. Fauna, no. 7. May 1893. p.253. Cal. (Syn. of S. vittatum Zett. according to Coquillett, Harriman Exp. 1900. p.393).

argyropeza. See reptans.

***bracteatum** Coquillett, U. S. Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Mass., Cal., N. Y., Kan., Mich.

calceatum Harris. A catalogue name according to Riley. Am. Ent. 1870. p.467.

cincta. See reptans.

***cinereum** Bellardi, Saggio di ditterologia Messicana. 1:13. Cal. (Townsend, Baja. etc. 1893). Mex. (Bellardi).

columbatchensis Fabricius nec Schönhauer. See reptans.

decorum Walker, List of Dipterous Insects, etc. pt1. 1848. p.112. Hudson Bay Ter. (Syn. of S. vittatum Zetterstedt, according to Coquillett, n. s. Bul. 10, 1898. p.68).

elegans. See reptans.

erythrocephala. See reptans.

***fulvum** Coquillett, U. S. Nat. Museum Proc. 1902. 25:96:
1898 ochraceum Coq. not Walk. Mont.; Id.; Col.; N. M.; Alaska.

***glaucum** Coquillett, U. S. Nat. Museum Proc. 1902. 25:97. Missouri.

***griseum** Coquillett, U. S. Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Col.

***hirtipes** Fries, Obs. Entomol. Pars. Monogr. Simuliar. 1824. p.17, 5. Tfl. 1, f.1. N. Y., Id., Cal.

The following synonymy is according to Schiner:
1830 rufipes Meigen, Syst. Beschr. 6:311-17.
1830 hirtipes Fries, Meigen, Syst. Bescher. 6:312-18.
1850 hirtipes Fries, Zetterstedt, Dipt. Scand. 9:3426-28.

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[1] Those names to which a * is prefixed I consider either a distinct species, or not sufficiently described to warrant placing as the synonym of another.

innoxium Comstock. See S. pictipes Hagen.

***invenustum** Walker, List of Dipterous Insects, etc. 1848. p.112. Hudson Bay Ter.

(pecuarum Riley is a synonym of this, according to Coquillett, 1898).

***irritatum** Lugger. Figured but not described in Univ. Minn. Agric. Exp. Sta. Bul. 1896. p.203.

***meridionale** Riley, Dep't Agric. An. Rep't for 1886. 1887. p.512.

1891 occidentale Townsend, Psyche, July 1891. p.107. Mass., Miss., Neb., Tex. (synonymy and localities according to Coquillett, Bul. 10, n. s. 1898), N. J. (Johnson), Kans. and Id.

***metallicum** Bellardi, Saggio di ditterologia Messicana. 1859. 1:14. Mex.

***mexicanum** Bellardi, Saggio di ditterologia Messicana, Appendix 6. 1862. Mex.

minutum Lugger, Minn. Agric. Exp. Sta. Bul. 1896. p.202. Minn. (Figured but not described). See vittatum.

molestum Harris. See venustum.

novicum Harris, Ins. Inj. to Veg. p.601. This is a Ceratopogon.

occidentale Townsend. See meridionale.

***ochraceum** Walker, Ent. Soc. London. Trans. n. s. 3:332. Mex.

***pecuarum** Riley (Synonym of invenustum according to Coquillett).

1887 pecuarum Riley, U. S. Dep't Agric. Rep't for 1886. p.512.

N. H., N. Y., Mass., Ct., D. C., Mich., Miss., La. (synonymy and localities according to Coquillett, U. S. Dep't Agric. Bul. 10, n. s. 1898), N. J. (Johnson).

***pictipes** Hagen, Bost. Soc. Nat. Hist. Proc. 1880. 20:305.

N. Y., Tex., Cal. (Coquillett, 1898) Id.

1895 innoxium Comstock. Name given in Manual for the Study of Insects.

piscicidium Riley. See venustum.

posticata Meigen. See reptans.

***pulchrum** Philippi, Chilian Diptera. 1865. p.633. S. Am. and St Vincent, W. I.

1896 tarsale Williston, Diptera of St Vincent, W. I. p.268. Synonymy according to Hunter, Catalogue of S. Am. Diptera. 1900.

***quadrivittatum** Loew, Berl. Ent. Zeit. 1862. Centur. 2, p.2. Cuba.

***reptans** Linnaeus, Fauna Suec. 1893. Europe, Greenland (Lundbeck, 1898). 1761.

Synonymy according to Schiner:

1767 sericea Linnaeus, Syst. Nat. 12:978, 58
1776 erythrocephala DeGeer, Ins. 6:161, 37 (Tipula)
1781 reptans L. Schrank, Enum. Ins. Austr, p.985 (Culex)
1787 colombatchensis Fabricius, Mantissa Ins. 2:333 (Rhagio)
1804 argyropeza Meigen, Classif. 1:96
1818 reptans Meigen, Syst. Beschr. 1:291-92
1818 sericea Meigen, Syst. Beschr. 1:296-98
1818 elegans Meigen, Syst. Beschr. 1:296-99
1818 variegata Meigen, Syst. Beschr. 1:292-93
1823 reptans Fries, Obs. Entomol. Pars 1 Monogr. Simuliar, p.13
1830 cincta Meigen, Syst. Beschr. 6:311, 14
1838 posticata Meigen, Syst. Beschr. 7:52, 21

rufipes Meigen. See hirtipes.
sericea Linnaeus. See reptans.
***tamaulipense** Townsend, N. Y. Ent. Soc. Jour. 1898. v.7. Tex.
tarsale Williston. See pulchrum Phillipi.
tribulatum Lugger, Minn. Agric. Exp. Sta. Rep't 1896. p.205–7. Probably equals vittatum. (p.385. Seq.)
(Figured but not described)
***venustum** Say, Acad. Nat. Sci. Phil. Jour. 3:28; Compl. Wr. 2:51
Wiedemann, Auss. zw. Ins. 1:71. Ohio, D. C. (Osten Sacken, catalogue). N. J. (Johnson); Can., N. H., N. Y., Mich., Minn., Wyo., B. C., Cal., Tex., La., Miss., Fla., (Coquillett); Id. The following synonymy is according to Coquillett. 1898.
1862 molestum Harris, Ins. Inj. to Vegetation. (Not described)
1870 piscicidium Riley, Am. Ent. 2:367. Mumford N. Y.
***virgatum** Coquillett, U. S. Nat. Mus. Proc. 1902. 25:97. New Mexico.
***vittatum** Zetterstedt, Ins. Lapponica. 1840. p.803. Staeger Groenl. Antl. Greenland (Osten Sacken's catalogue); N. J. (Johnson); Alas. (Coquillett 1900); Cal., Kan., Minn., N. Y., Neb. (Coquillett 1898), Id., S. Dak. The following synonymy according to Coquillett.
1848 decorum Walker, List. Ins. p.112. Hudson Bay Ter.
1893 argus Williston, N. Am. Fauna, no. 7, p.253. Cal.

KEY TO SPECIES OF SIMULIUM

Larvae

1 Mature larva 6 or 7mm long, with the dorsal surface of the head nearly white; the rays of the fan number about 30. Larva from Santa Cruz mountains, Cal. [p.387].
Head usually brown; rays of the fan usually 40 or more............(2)
2 The top of the head with six black blotches or spots. Larvae from New Mexico [p.386].
Head without six dark spots....................................(3)
3 The caudal blood gills are three simple papillae......................(4)
The three main branches are again subdivided......................(6)
4 The middle tooth of the labium is simple and pointed, labium with six pairs of setae on its ventral surface [pl.35, fig.2].vittatum
The middle tooth at least is trifid..................................(5)
5 All marginal teeth of the labium except the outer pair are trifid ....hirtipes
The middle tooth only is trifid; ventral surface with three pairs of setae [pl.33, fig.8]......pecuarum (=invenustum)
6 Full grown larvae 10-12mm in length, black in color, its labium with an elongate middle tooth [pl.36, fig.3].........pictipes
Paler larvae less than 10mm in length..............................(7)
7 No setae on the last joint of the maxillary palpus, middle tooth of the labium longer than the two lateral ones, four pairs of setae on its ventral surface. The pair of apical setae of the mandible not differentiated from the hairs which overhang the apex..........................meridionale

Mandible with a pair of apical bristles, palpus of the maxilla with setae ....(8)
8 Middle tooth of the labium enlarged, ventral surface of labium with five pairs of setae [pl.37, fig.6]...........venustum
Middle tooth not enlarged (varieties of venustum).............(9)
9 Labium with four pairs of ventral setae [pl.37, fig.14].........var. a
With seven pairs of setae [fig.5]...............var. piscicidium

Pupae

(Arranged according to the number of filaments in each respiratory tuft)

1 With six filaments
  a Legs in their cases appear bicolored[1]...............venustum
  b Legs unicolored..................................meridionale
2 With eight filaments
  a Pupa 4.5mm long; Arizona species. Pupa described in Am. Ent. Soc. Trans. p.45. 1893.
  b Less than 4mm long; eastern species.................. venustum, var. piscicidium
3 With nine filaments. Pupal case like that on pl.35, fig.5...pictipes
4 With 10 filaments..........................var. a of venustum
5 With 12 filaments. Pupal case [pl.35, fig.5]. From Santa Cruz mountains, Cal. [p.387]
6 With 16 filaments.......................................vittatum
7 With 24 to 48 filaments [pl.33, fig.10]..................pecuarum
8 With 60 or more filaments...............................hirtipes

Imagines

1 Ground color of the thorax and abdomen deep yellow..............(2)
Gray or black; its hairs may be pale..............................(3)
2 "Femora with black tip, length of fly 2mm." Mexico..ochraceum
"Femora without black tips. Length 3 to 4.5mm. Rocky mountains" ....fulvum
3 Hind tarsi with its basal joint partly yellow; legs bicolored ....(9)
Hind tarsi unicolored[2]...(4)
4 Halteres dusky; thorax not striped..............................(5)
Halteres white or yellow; the female with striped thorax and bifid tarsal claws..(6)
5 Body black; the female with dense yellow pile, her tarsal claws simple; the male with dense hair on the legs, his tarsal claws trifid. The wing with its radius three branched. Length 3 to 4.5mm.........................hirtipes
"Body gray, legs reddish gray, feet black; length 3mm." This is said by Mr Coquillett to be the same as pecuarum Riley ....invenustum
6 Males, eyes contiguous...(7)
Females, eyes separated by a distinct line.........................(8)

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[1] In order to see this it will be necessary to examine nearly mature specimens and perhaps to draw them from their pupal skins.

[2] The male of pictipes sometimes has legs nearly unicolored; it is however included in the preceding section.

7 Thorax velvety black; legs reddish with black tarsi. Length 1.5 to 2mm. Compare here also bracteatum (male), "with legs wholly brown."........................meridionale

Thorax brownish black; legs usually pale; tip of tarsi not black. Length from 2 to 4mm........................pecuarum

8 Thorax with silvery white pubescence; legs brownish black, covered with whitish hairs. A small variety (less than 2mm long), from New Mexico has been named occidentale Town. (q. v.)..............................meridionale

Thorax with yellow hairs; legs reddish brown, covered with yellow hair; tip of tarsi blackish.....................pecuarum

9 Males, eyes contiguous...(10)

Females, eyes separated..(20)

10 "Mesonotum wholly velvet black; gray spot on sides of the second, fifth, sixth, and seventh segments of abdomen. Length 1.5mm." ....bracteatum

Metanotum striped, or with grayish or metallic reflections.........(11)

11 Dorsum of thorax with one or more longitudinal stripes...........(12)

Dorsum unstriped ....(14)

12 Thorax with four longitudinal stripes; posterior margin white; abdomen black. Sex not given. Cuban species.... quadrivittatum

Thorax not so marked..(13)

13 Front and middle femora and tibiae wholly yellow; center of mesonotum with a black vitta, elsewhere gray. Length 1.5mm. Colorado species ....griseum

Femora and tibiae wholly or partly brown.......................(13a)

13a "Femora and front tibiae yellow, their apices brown; middle tibiae brown, a yellow ring beyond the base, hind tibiae brown, the extreme base yellowish. Mesonotum marked with a narrow median and laterally with a very broad velvet black fascia." Length 3mm. New Mexico.....virgatum

Front femora brown, tibiae brown on apical part................(13b)

13b Mesonotum with two narrow gray stripes (sometimes quite indistinct) on a velvet black ground, in which there are scattered golden hairs................................vittatum

"Mesonotum marked with a narrow median and slightly wider lateral black vittae." Length 2.5mm. Missouri..glaucum

14 Anterior femora yellow. Mexican species.......................(15)

Anterior femora black...(17)

15 Abdomen with the base of the second segment, and the sides of the third, fourth, and fifth yellowish white; tibiae fuscous black with yellow bases. Length 4mm........mexicanum

Abdomen black ....(16)

16 Metallic bluish black species; middle portion of fore tibiae, base of middle and hind tibiae, base of first and second joints of middle and hind tarsi, whitish. Length 2mm... metallicum

Thorax fuscous and cinereous pollinose; the humeri pallid, fore coxae pale, middle and hind ones dark; femora pale at the base, black at the tip; tibiae black. Length 3mm..cinereum

17 An oblique metallic streak extending inward from each humerus; posterior part of the thorax metallic. Length 2 to 2.5mm.......................................venustum

Humeral spots not metallic.......................................(18)

18 Anterior coxae yellow; long hair on femora and hind tibiae; thorax velvet black with white pruinose margin (Greenland) ....reptans

Anterior coxae black.......................................(19)

19 Thorax velvet black, with oblique cinereous humeral spots, and usually two tiny metallic spots between them. Length 3 to 4mm.......................................pictipes

Thorax velvety black with two very narrow gray stripes and posterior margin; hind tibiae usually yellow at the base, hair on legs sparse..............................vittatum

20 Thorax striped.......................................(21)

Thorax without stripes.......................................(25)

21 Dorsum of thorax with four longitudinal lines, posterior margin, white pollinose; abdomen opaque black. Cuban species ....quadrivittatum

Not with four stripes.......................................(22)

22 Dorsum of the thorax with five stripes, the outer ones spotlike, the intermediate ones clubbed at the ends; abdomen with black fascia on each segment, produced posteriorly at the middle and the ends. Sometimes the last few segments have only three or five spots....................vittatum

Thorax with one or three stripes.......................................(23)

23 With three stripes.......................................(24)

"With an indication of a darker median vitta" [*see* 31]....griseum

24 Small species, length about 1.5mm. "Abdomen silvery, third and fourth segments wholly brownish, sometimes with a median spot on each; legs yellowish, tarsi blackish or brownish." Species from Texas..............tamaulipense

Larger species 3mm. or more in length...........................(24a)

24a Middle tibiae brown with a yellow ring beyond the base; vittae of mesonotum brownish, the median vitta dilated posteriorly, wider than either of the lateral ones. New Mexico ....virgatum

Femora and tibiae grayish. sometimes quite pale, tips of tibiae black. Laterodorsal thoracic stripes clubbed at the anterior end. Third, fourth, fifth, and part of sixth and seventh abdominal segments with velvet black fasciae; center of 6, 7, and 8, grayish or dull brown..............pictipes

25 Abdomen without distinct black spots...........................(26)

Abdomen spotted.......................................(31)

26 Abdomen black, covered with long yellow pile; legs yellow, the tips of the femora and tibiae, and all the tarsi except basal two thirds of the hind metatarsi, brown......bracteatum

Abdomen nearly bare.......................................(27)

27 Body gray or cinereous.......................................(28)

Body brown or black.......................................(29)

28 “Body gray with a white milky luster, specially the pleura and pectus. Legs tawny, femora and tibiae with irregular piceous bands, tarsi piceous. Length 2.5mm. Hudson Bay Ter.” This is a synonym of vittatum Zett. according to Mr Coquillett (1898)........................decorum

Thorax fuscous or cinereous pollinose, humeri pallid, pleura pale cinereous, scutellum pale at the tip; abdomen blackish; fore coxae pale, middle and hind ones cinereous; femora pale at the base, black at tip; tibiae black. Length 3mm. Mexican species..............................cinereum

29 Abdomen somewhat shining, yellowish gray or whitish at the sides, and yellow at the base; legs brown, tibiae and fore coxae white, tip of tibiae and all tarsi black. European species, also occurring in Greenland................reptans

Basal segments of abdomen opaque, distal four segments somewhat shining black or brown. Two long hairs at the tip of the first and third fore tarsal joints......................(30)

30 Legs reddish yellow, tarsi black, except proximal half of middle and hind metatarsi which are light yellow. Length 2mm. (St Vincent island) This is a synonym of pulchrum Phil. according to Hunter.................tarsale

Legs black, base of tibiae, first joint of middle and hind tarsi and sometimes base of femora yellow; extensor surface of all the tibiae more or less whitish. A widely distributed and variable species........................venustum

31 Length 1.5mm. Front and middle femora and tibiae wholly yellow; hind ones, except apices, also yellow. (Colorado).griseum

Length 2.5mm. Legs brownish black, distal part of femora, base of tibia, and greater part of metatarsi light yellow. (California) ....argus

Some of the characters used in this table have been taken from the key given in United States Department of Agriculture, division of entomology, bulletin 10, new series, 1898, page 68, by Mr Coquillett. In the table given above, I have included all the North American species. For the southwestern and Mexican species it should however be used with caution as I did not have specimens of some of these.

Descriptions of the species

S. argus Williston

N. Am. Fauna, No. 7. May 1893. p.253. Cal. (Syn. of S. vittatum Zett. according to Coquillett, Harriman Exp. 1900. p.393)

Female. Black, the legs in part light yellow; front black, opaque; face cinereous, with whitish pubescence; antennae brownish black, the basal joint yellowish; thorax black, the dorsum thinly pollinose; not shining; pleura densely white pollinose with a black spot; abdomen opaque velvety black, the first three segments with a narrow silvery white spot on either side at the hind margin, the next three segments similarly marked, but the interval between the spots successively wider, and each with two other, successively larger, white spots, leaving a black space in the middle and a narrower one at the outer sides; venter white; legs brownish black, the distal part of the femora, base of tibiae, and the greater part of metatarsi light yellow; wings pure hyaline, the veins light colored, those posteriorly very delicate. Length 2.5mm.

One specimen, Argus mountains, Cal. May 1891.

[1]Coquillett makes this a synonym of vittatum Zett., though nothing is said above of the handsomely marked thorax so conspicuous in the female of vittatum.

S. bracteatum Coquillett

Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Mass., Cal., N. Y., Kan., Mich.

Female. Dorsum of abdomen deep black, not marked with gray, quite densely clothed with nearly erect yellowish tomentum; mesonotum also deep black and covered with appressed golden yellow tomentum; pleura grayish black; legs nearly bare, yellow, apexes of femora and of tibiae, and whole of tarsi except the basal five sixths of the first joint of the hind ones on brown; first joint of front tarsi scarcely dilated, the first joint of the hind ones one half as wide as their tibiae; head gray, covered with a pale yellow tomentum; antennae black, the two basal joints yellow, mouth parts black; wings hyaline, costal, first three veins and first section of the fourth, yellow, the remainder subhyaline. Length 1.5mm.

Cambridge Mass. (May 31, 1889) and Los Angeles county, Cal. Two females, the one from California captured by the writer.

Male. Mesonotum wholly velvet black; abdomen with a gray spot on the sides of the second, fifth, sixth and seventh segments; legs almost wholly brown, otherwise as in the female. Two male specimens taken with the female.

Some female specimens believed to be this species received from Professor Aldrich, and a single specimen caught on a window in Ithaca, Oct. 16, by the writer agree perfectly with Mr Coquillett's description excepting that the abdomen of these specimens has two longitudinal rows of small spots which are not covered by the yellow tomentum. This was particularly noticeable in the fresh specimen, but, as drying caused shrinkage of the abdomen, the spots are no longer so distinct.

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[1] Wash. Acad. Sci. "Harriman Exp." 1900. p.393.

The fore tibiae are each provided with a single spur, the middle and hind ones each with a pair. The tarsal claws are each provided with a large basal tooth or lobe [pl.38, fig.15]. The halteres are pale yellow.

Cambridge Mass. and Los Angeles Cal. (Coquillett, 1898); Lawrence Kan. and Battle Creek Mich. (Collected by Professor Aldrich); Ithaca N. Y.

S. cinereum Bellardi

Saggio di ditterologia Messiana. 1859. 1:13

Male and female. Gray, antennae black, first joint pale. Thorax fuscous and gray pollinose, the humeri pale; pleura light gray; scutellum pale at the tip; halteres white. Abdomen blackish. The front coxae pale, the middle and hind pair grayish brown; the femora pale at the base, their tips black; tibiae black, their middle section pale; front tarsi wholly black, the middle and hind pair with the bases of first and second joints pale. Wings hyaline. Length of body 3mm; with extended wings 9mm.

Mexico, California (Townsend, 1893).

S. decorum Walker

List of Diptera. Brit. Mus. 1848. p.112

Cinereum, argenteo micans, antennis piceis, pedibus fulvis, femoribus tibiisque piceo fasciatis, tibiis posticis tarsisque posterioribus basi albis, alis limpidis. Body gray, adorned with white milky luster, specially on the sides of the chest and on the breast; feelers piceous; legs tawny; thighs and shanks with irregular piceous bands; feet piceous; fore thighs adorned with white luster; hind shanks and four hinder feet white at the base; wings colorless; fore border veins pale tawny; the other veins still paler and very indistinct; poisers pale yellow. Length of the body 2.5mm; of the wings 6.5mm.

St Martin's falls, Albany river, Hudson bay. Presented by Mr G. Barnston.

According to Mr Coquillett,[1] decorum is a synonym of S. vittatum Zett.

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[1] U. S. Dep't Agric. Bul. 10, n. s. 1898.

In the report of the Minnesota Experiment Station, Bulletin 48, 1896, page 202, is given a figure of a female fly which is said to be S. decorum. In this figure the thorax is represented as unicolored, the abdomen with the anterior half of the second segment, a semicircular spot on the anterior margin of the segments 3, 4 and 5, a blotch on the sixth, and all of the remaining segments dark; legs dark, excepting the middle section of all the tibiae, a part of the middle and hind femora, and the basal two thirds of the hind metatarsi. No description is given, but the author stated that this fly occurs in large numbers in Minnesota during June and July. Some specimens kindly lent by Mr Washburn from the Minnesota Experiment Station Collection, bearing the label S. decorum proved to be S. vittatum (♀).

S. fulvum Coquillett

U. S. Nat. Mus. Proc. 25:96

Eight female specimens received from Professor Aldrich of Moscow Id. which I have examined, agree pretty well with Walker's description of ochraceum, excepting that in no case is there a trace of black at tip of femora, the tarsi are only slightly darker than the tibiae, and not black, and the length, which according to Walker is 2mm, is nearly double that in these specimens. The description of the Idaho specimens is as follows:

Deep yellow or ochraceous; the head, upper surface of antennae particularly at the incisures and the two basal joints, the mouth parts, sides of thorax at the base of the wing, the abdomen except the basal segments the tips of the tibiae and all the tarsi, particularly the fore and middle pair, and their flexor surfaces, and the hind metatarsi, more dusky than elsewhere. In fact, in some specimens the tarsi and the abdomen may be described as blackish. The head, dorsum of thorax and abdomen are covered with short, sparse, pale yellowish pile. Legs are without long hair; all tibiae with spurs; the tarsal claws simple. Halteres dusky yellow. Wings hyaline, slightly blackish at tip, subcostal cell yellow, the veins yellow except the apical half of the veins of the anterior margin, which are blackish. A yellow cloud follows the course of the media and the anal veins, as in pl.34, fig.1, of hirtipes. Venation as in hirtipes, the vein R_{2+3} being present; but M_{1+2} bends down into cell M_{1+2} slightly more than in the wing just mentioned. Length 3.5 to 4mm. Length of one wing 5mm. According to Mr Coquillett the species also occurs in Colorado and Montana [pl.38, fig.21].

Moscow Id. (June 19).

S. glaucum Coquillett

U. S. Nat. Mus. Proc. 1902. 25:97

Male. Head and body black, face gray pruinose, thorax bluish gray pruinose, mesonotum marked with a narrow median and slightly wider lateral black vittae, broad lateral margins, when viewed from behind silvery white, a pair of large subquadrate spots on the front end separated by the median black vitta, which is here greatly dilated; abdomen velvet black, sides of segments two and five to nine silvery, middle of dorsum of four also silvery; venter almost wholly silvery; femora and tibiae brown, bases of tibiae yellow, anterior side of front ones largely silvery; tarsi black, broad base of first joint of the middle and hind ones whitish; wings hyaline, veins along the costa yellowish brown, the others nearly hyaline; halteres yellow; length, 2.5mm.

In April. Kansas City, Missouri.

S. griseum Coquillett

Dep't Agric. Div. Ent. Bul. 10, n. s. 1898. p.69. Colorado

Female. Front and middle femora and tibiae wholly yellow, hind ones except their apexes also yellow, tarsi brown, bases of the first two joints of the middle and hind ones yellow; mesonotum grayish, indications of a darker median vitta, the sides and front corners yellow, pleura light gray, scutellum yellow; abdomen gray, segments 2 to 6 each marked with three velvet-black spots; wings hyaline, the costa, first three veins, and first section of the fourth, yellow, the others subhyaline; face and front light gray, antennae brown, the two basal joints yellow, palpi black, proboscis yellowish. Length 1.5mm. Colorado. Three females, collected by Mr Carl F. Baker.

Male. Center of mesonotum with a narrow black vitta, mesonotum elsewhere gray, dorsum of abdomen velvet-black, the second and seventh segments and a spot on the sides of the eighth, silvery gray, otherwise as in the female. A male taken with the female specimens.

S. hirtipes Fries

Obs. entomol. Pars 1. Monogr. Simuliar. 1824. 17:5, Tfl. 1, f.1.
1830 rufipes Meigen, Syst. Beschr. 6:311-17
1830 hirtipes Fries, Meigen, Syst. Beschr. 6:312-18
1850 hirtipes Fries, Zetterstedt, Dipt. Scand. 9:3426-28

Male. Black. Eyes contiguous, upper facets larger than the lower; antennae brownish black, including the two rather elongate basal joints, sparsely covered with short grayish white pile; palpi black, hairy, four jointed, the second joint rather wide and flattened. Thorax black, unstriped, the dorsum sparsely covered with an appressed, golden yellow pile, mixed with some black hairs; the scutellum black, with a tuft of long, nearly erect yellow hairs on each side; metanotum black, nearly bare; pleurae brownish black, bare and subshining.

Abdomen black, the basal half of each segment velvet-black, the apical half of each segment (sometimes only the margin) subshining, brownish black, everywhere thinly covered with an appressed pile of yellowish brown and black hairs, the yellow hairs visible only in certain lights, so that both thorax and abdomen appear black. On each side on the leaflike posterior margin of the first abdominal segment is a fringe of long, dark brown hairs. Legs brown to brownish black, including the coxae; the tarsi are usually slightly darker; anterior tibiae with one spur, middle and hind tibiae each with a pair; the legs, particularly the posterior ones, densely covered with pale brown or yellowish hairs, posterior metatarsi as long as the following four joints taken together, wider than the tibia, flattened laterally; all tarsal claws tridentate. Halteres entirely black. Wings brownish yellow tinged, and usually both branches of media, and the first and second anal veins brown clouded. This is most apparent in a balsam-mounted wing. The radius is three branched [see figure]. Length of dried specimens 3.5 to 4.5mm.

Female. Black, everywhere thickly covered with golden yellow, appressed pile, so that the fly appears somewhat yellowish. Eyes separated, the front black with appressed yellow pile; antennae brownish black, the first two joints paler, sparsely covered with short, appressed pale yellow pile, and a few scattered black hairs; palpi dark brown, the mouth parts reddish brown with black tips. Dorsum of thorax black, unstriped, thickly covered with golden yellow, appressed pile; scutellum black, with a tuft of long, nearly erect yellow hairs at the sides, metanotum subshining, brownish black, bare; pleurae brownish black, bare, and subshining. Abdomen black, when viewed from behind the posterior margins of the segments often appear yellowish white; wholly covered with yellow appressed pile. On the sides of the leaflike, posterior margin of the first abdominal segment is a fringe of long yellow hairs. The coxae are black; legs yellow, the knees, the tips of the tibiae and all the tarsal joints slightly darker, the anterior tarsi specially, sometimes brown; hind metatarsi elongate and flattened, though not so wide as in the male. Anterior tibiae each with one spur, middle and hind tibiae each with a pair. The tarsal claws are simple; wings as in the male, though the media and anal veins are unaccompanied by the brownish cloud. Halteres fuscous, peduncle slightly paler. Length of dried specimens 3.5 to 4.5mm; wing, 3.5 to 4.5mm.

Described from many bred and captured specimens, from Coy glen, Ithaca N. Y., May 1901, and Adirondack mountains, June 1901, Moscow, Spaulding and Peck, Id.; from Professor Aldrich.

I have compared this with European specimens, and find that they agree in every particular excepting that the foreign specimens I have are a little smaller. A number of female specimens collected by Messrs McGillivray and Houghton on Mt Seward in the Adirondacks, agree perfectly even in size with those from Europe. According to the testimony of the gentlemen named, these flies are most persistent biters. Those found around Ithaca are known to annoy horses, and also have been caught biting human beings.

Larvae. In this State they are found in the latter part of April and the first two weeks of May; most of them pupating before the middle of May; the adults appearing eight or nine days after pupation. Some adults appear as early as May 1. The head of the larva is quadrangular, of a rich brown color, the posterior margin nearly black, with a black, divided eye spot on each side. The antennae are slender, first joint occupies about two thirds the whole length, the third joint being pointed, and but little longer than wide [pl. 34, fig. 5]. The fans have 30 to 50 scythe-shaped rays, each with a row of fine cilia on the inner side, at regular intervals with a longer and stouter seta [pl. 34, fig. 8]. The mandibles are stout, with the usual teeth, the apical ones being black, the others paler. The large one most remote from the apex is not so differentiated as with other species. The pair of apical bristles is partly hidden by the hair at apex. The maxillae are wider than long; the palpus being only about twice as long as broad. At the base of the palpus is a tuft of fine setae, and covering it are a few slender bristles [pl.34, fig.3]. The labium has seven apical teeth, all but the outer ones being trifid; on its ventral surface are two rows of five bristles each [pl.34, fig.4]. The labium and hypopharynx as in the other species. The dorsal surface of the thoracic segments is of a dirty yellow color, the ventral surface is nearly white. On each side is a triangular shaped spot which marks the position of the future respiratory filaments of the pupa. The basal half of the thoracic proleg is fuscous, its apex paler. Extending from the base of the proleg to the first abdominal segment is a broad, dark line with sinous margins. The abdomen is fuscous, paler at the sutures and on the ventral surface. The underside of the last two or three segments is nearly white. The hooks (about 100 rows, 12 in a row) forming the margin of the sucker are dark brown [pl.34, fig.11–12]. In some specimens a fine fuscous line extends the whole length of the ventral surface on the median line. Just before pupation the developing ventral hooks of the pupa become visible. Though retracted in nearly all the material studied, I have found that the blood gills of the last abdominal segment consist of three unbranched lobes.

Pupa [pl.34, fig.10]. Rich brown in color; the two tufts of thoracic respiratory filaments (one tuft on each side) are each divided primarily near the base into four main branches, the two inner ones larger than the outer ones, each branch again dividing two or three times into twigs, so that upward of 60 filaments may be counted. On the ventral surface close to the posterior margin of the last six abdominal segments are four larger upward curved spines; on the dorsal surface near the base of each abdominal segment is a close row of spines projecting caudad, and on the dorsal and lateral surface of these segments, a short distance from the margin, is a row of fine spines projecting cephalad. The last named are not quite so close to the margin, nor are they nearly as large. In the figure the segments are contracted, and the caudad projecting spines appear to be attached to the posterior margin, whereas they belong to the middle of the dorsal surface of the following segment. At the apex of the last segment are two stout hooks projecting dorsad and cephalad. The pupal cases consist of a dark matted mass of silk, of no definite form, secreted on the rock, and in which the pupae are partially imbedded. The pupal life lasts about eight or nine days.

From Professor Kellogg (Leland Stanford Jr University, Cal.) I received specimens of larvae and pupae which agree very closely with those just described. These specimens (collected on the university campus) appear to differ only in that the labium of the larvae possesses but three bristles in each row on the ventral surface. Specimens from Professor Aldrich (Idaho) are identical with those from New York State.

S. invenustum Walker

List of Diptera. Brit. Mus. 1848

Nigrum, cinereo subfuscum, abdomine basi fulvo hirto, antennis piceis, pedibus fulvis, alis limpidis. Fem.; *Cinereum, antennis nigris, pedibus rufo-cinereis, tarsis nigris.*

Body black, overspread with a grayish bloom; base of the abdomen clothed with tawny hairs; feelers piceous; legs tawny and clothed with tawny hairs; wings colorless; fore border veins brown; the other veins tawny and slender; poisers piceous. Female. Body gray; feelers black; legs reddish gray; feet black.

Length of the body 3mm; of the wings 7mm.

St Martin's falls, Albany river, Hudson bay. Presented by Mr G. Barnston. This is said by Mr D. W. Coquillett to be the species which C. V. Riley called pecuarum.

S. irritatum Lugger

Minn. Agric. Exp. Sta. Bul. 48. 1896. p.204

Figures are given of both male and female in the bulletin, but without description. Neither is its life history given, though it was apparently known to Mr Lugger. Both the male and female are represented with an unstriped thorax, a fasciate abdomen, and bicolored legs. The male appears to have a light spot on the anterior margin of each segment of the abdomen and a pair of spots on the anterior margin of the thorax. This species is said to be the most common black fly in the central part of Minnesota.

It is to be hoped that this species may again be found and fully described in the near future.

S. metallicum Bellardi

Saggio, etc. 1859. 1:14

Male. Metallic blue black. The base of the antennae, the halteres, the fore femora, the middle portions of the fore tibiae, the bases of the middle and hind tibiae, the bases of the first and second joints of the middle and hind tarsi, are white. Wings hyaline; its veins rather indistinct. Length of body 2mm; extended wings 5mm. Mexico.

S. meridionale Riley

Dep't Agric. An. Rep't for 1886. 1887. p.512 (turkey gnat) 1891; S. occidentale Townsend, Psyche, July 1891, p.107 (synonymy according to Coquillett).

Female. Length 2.5mm to 3mm. Head uniform slate-blue, verging to greenish, or cerulean blue in some lights, clothed with silvery pubescence, which becomes longer behind the eyes; parts below the antennae and trophi more densely pubescent, producing the effect of a white face; eyes with a metallic coppery luster; antennae black with very dense white pubescence; no bristles on basal two joints, which are but very slightly tinged with red; joint 1 shortest; joints 2, 3, and 11, subequal in length; joint 3 widest; joints 4 to 9 subequal in length; joint 10 but slightly shorter than joint 11, which is fusiform; joints 3 to 11 gradually decreasing in width. Maxillary palpi as long as antennae, blackish, with long, whitish bristles. Thorax slate-blue, with less dense, silvery white pubescence; markings quite distinct, producing the effect of a sculpture, and consisting of three black longitudinal lines, the median narrow, widening a little at the apex, and the outer one curving inward at base, and outward at apex, sometimes reaching to base of patagium, which appears whitish on account of the dense pubescence; on the lateral edges of prothorax are fine black sutures; underside uniform slate-blue, with sparse pubescence; space around the large stigma almost white. Halteres white, very faintly tinged with red. Abdomen nine jointed, joints subequal in length, except the last two, which decrease; markings entirely different from those of S. pecuarum, formed by velvety black, dark blue and bluish white, almost silvery, colors; the dark blue appears on dorsal surface of the last five segments, spreading from a roundish median spot, on 5 to the immaculate blue of the last two segments; segments 2, 3, and 4 have each a black cross-bar, and 5, 6, and 7, two narrow, black submedian stripes, which disappear almost entirely on 7; the bluish white forms an outer edge to all the black and extends over the whole lower surface of the abdomen, with the exception of more or less well marked black cross lines in middle of each segment; a bluish white or silvery pubescence covers the entire abdomen, but is very sparse on the dorsal parts. Legs brownish black; tarsi almost black, and more or less densely covered with white hairs. Wings, subhyaline. Veins bluish white, base ferruginous. Described from many bred and captured specimens.

Male. Length 1.5mm to 2mm. Very different in appearance from female. Eyes confluent, very large, brilliant coppery; a very marked difference in the size of the facets, those on upper surface being very large and metallic copper, those below and surrounding trophi becoming suddenly small, black, with bronze reflections; trophi reddish black, dwarfed; antennae black, with light, yellowish brown pubescence in front. Thorax above intense black, velvety with a bluish luster; underside grayish. Legs reddish with black tarsi. Wing hyaline, veins and base bluish white. Abdomen; above, black with posterior margins of segments edged with gray; undersides of segments 2 and 3 light, reddish gray, the others blackish, with gray posterior margins. Sexual organs black. Thorax and abdomen very sparsely clothed with white pubescence. Described from three bred specimens.

Larva. Length when full grown 5.5mm to 7mm. Normal shape and general appearance differ from S. pecuarum by the much more irregular markings of segments and head. A majority of the larvae possess one or two lateral spots on club-shaped posterior third of body. Head lacks the regular arrangement of spots and lines, which become confused; the two black spots on each side present. Antennae uniformly pale, much longer than in pecuarum, slender and three jointed; first joint almost twice as long as joints 2 and 3 together, and a little bent; at base three times and at tip twice as thick as second joint, which is nearly uniform in width, tapering but very slightly toward the tip; joint 3 small and pointed, about one fifth as long as joint 2. Mentum similar to that of S. pecuarum, but distinguished by a flatter apex, by the possession of three erect bristles on each side, starting from round pores, which decrease in size toward base; a fourth very small bristle close to base, and in line with the bristles above; the sides of mentum have on each side four sharp teeth. Labrum and labium not different from those of pecuarum. Mandibles possess but seven teeth in the first row; the three first nearly uniform in length; teeth 4 to 7 gradually decrease in length; tooth 4 much the longest of all; the two teeth in the second row similar to those of pecuarum. Maxillae and maxillary palpus also similar. Fans similar, but the hairs lining the inside of the scythe-shaped rays are thicker and nearer together. Prolegs, more slender, last joint bearing a crown of hooks, usually bent suddenly toward head. Tip of abdomen similar to that of pecuarum. Breathing organs quite different; the three main trunks branch each six times, and the branches enter the trunk from both sides. Full grown larvae show also the newly formed, coiled breathing tubes of the pupae through their skin. Described from many specimens.

Pupa. Average length 3.5mm; shape and colorations as in S. pecuarum. The thoracic filaments consist only of the six original rays, which do not branch. On dorsal surface of the posterior margins of abdominal joints 4 and 5 is a row of eight anteriorly curved hooks, similar to those of pecuarum, but none on joint 3; anterior margin of joint 9, and of subjoint with a continuous row of smaller, anteriorly curved hooks; joints 7 and 8 unarmed dorsally; ventrally joints 6, 7 and 8 have each four minor hooks.

Cocoon. Length 3.5mm. Neater than that of any other species known to me, being formed of fine threads, lined with gelatinous ones. The web is quite dense, uniform, with well defined, sometimes thickened ribs. The cocoon is always securely fastened singly to leaf or stick, and if many are fastened on the same leaf, they do not crowd each other. It fits snugly about the pupa, which is so securely anchored inside as to be with difficulty extricated.

Several female specimens taken by Messrs MacGillivray and Houghton at Axton N. Y. in company with S. vittatum agree perfectly with Coquillett's description, though not so well with Riley's. Coquillett's description of the female in United States Dep't Agric. bulletin 10, new series, reads as follows:

> Abdomen of female gray, marked with a velvet-black fascia on segments 3 and 4, and sometimes with two subdorsal spots of the same color on 2, 5 and 6; thorax bluish gray with three black vittae.

The blue color on the abdomen spoken of by Riley in his description is not distinguishable in the dried cotype specimen, the posterior segments appearing grayish. In the male the thorax is velvety black, with a few pale yellow hairs, specially anteriorly and posteriorly. The abdomen is velvet-black, the posterior margins of segments sometimes pale. The fore tibia possesses a single spur, the middle and hind ones each with a pair [pl.38, fig.12]. All tarsal claws of the male trifid [pl.38, fig.18]; of the female bifid [pl.38, fig.16].

It may be mentioned that what Riley calls mentum I have termed labium. To Riley's description of the larvae may be added that the apical pair of bristles of the mandible is not present or at least is not differentiated from the other hairs; the labrum and hypopharynx [pl. 33, fig.11, 3] resemble those of other species; the labium has four pairs of setae [pl.33, fig.4], one of which is quite small; the maxillary palpus has no setae on the last joint, and but few hairs on the basal joint. No spines are apparent at tip of the last abdominal joint of pupae, the other spines and hooks are as described by Riley. This species has been reported from New York. I have also seen specimens from Moscow and Albion Id., Lawrence Kan. and Axton N. Y.; those from Idaho and Kansas belonging to Professor Aldrich.

S. mexicanum Bellardi

Saggio etc. Apx. 6. 1862

Male. Black. Head black, front prominent, triangular, with whitish reflection; antennae black, first joint and base of second yellow; face prominent, black, the epistome yellowish, with grayish reflection; palpi black, paler at the base; thorax wide, subquadrate, slightly convex, black, with a grayish reflection, with yellow pile? (aureo-squamuloso); humeri pale; pleurae black, anteriorly and posteriorly with fuscous spots; scutellum fuscous; the halteres white; abdomen black, the base of the second segment pale yellowish, the second, third, fourth and fifth pale yellowish on the sides; fore and middle coxae wholly yellow, hind ones fuscous with yellow tips; fore femora wholly yellow, the middle and hind pairs fuscous black, at base and tip yellow; all tibiae fuscous-black with yellow bases; fore tarsi wholly black; middle tarsi black, with bases of all the joints yellow; hind tarsi black with base of first joint widely and second joint narrowly yellow; wings hyaline iridescent. Length 4mm; extended wings 9mm.

Mexico.

S. minutum Lugger

(= S. vittatum Zett.)

Minn. Agric. Exp. Sta. Bul. 48. 1896. p.202.

The bulletin mentioned above contains a figure of the female of a species which is said to be common near Minneapolis from May 15 to June 1. No description is given excepting the statement that it is very small. The figure represents a fly with an unstriped thorax, the abdomen with a dark fascia on each segment, the fascia covering nearly the entire dorsal surface of each segment, excepting the narrow basal and lateral margins. Its legs are bicolored. Specimens bearing the label S. minutum received for study from Mr Washburn proved to be S. vittatum Zett.

S. occidentale Townsend

Psyche. 1891

Female. Cinereous; abdomen light fulvous. Head cinereous, eyes black; face cinereous, raised and somewhat darker in the center, sparsely clothed with fine silvery hairs; front cinereous, widened below into a crossbar, a prong invading the orbital area on each side; silvery pubescent on occipital margin; proboscis black, brownish at the tip, palpi black; antennae cinereous, with short silvery pubescence, the two basal joints longer than the following joints, which are nearly equal in length; occiput cinereous with silvery pubescence around the margin.

Thorax cinereous, mesoscutum entirely covered with silvery pubescence, with two dorsal lines and usually a fainter median line between them; pleurae fulvous posteriorly, scutellum black, silvery pubescent. Abdomen light fulvous sparsely covered with short silver pubescence. Second, third and fourth segments above with a brown cross band shading to darker on the sides and in the middle, particularly on the third and fourth segments, remaining segments with a broad, median, dorsal, cinereous band, bounded laterally on fifth, sixth and seventh segments by a curved more or less faint line of brown; venter light fulvous, silvery pubescent. Legs black, silvery pubescent. Wings hyaline, iridescent by reflected lights; halteres white. Length of body 2mm; of the wings 2mm.

Described from many fresh specimens. This species is smaller than either S. pecuarum, or S. meridionale. S. metallicum Bell. from Mexico is given as 2mm long, but the male is described. The female would be much larger.

I have examined specimens from New Mexico, kindly sent me by Professor Aldrich of Idaho, to whom the specimens were sent by Mr Townsend, and named occidentale. The only difference I have been able to discover between this and meridionale is its smaller average size. The tarsal claws are as in meridionale. The abdominal markings were too indistinct, owing to shrinkage, to allow of comparison. For the present I regard it as a small variety of meridionale.

S. ochraceum Walker

Ent. Soc. Lond. Trans. 5:332

Female. Testaceous, with white tomentum; head white; antennae testaceous; thorax ochraceous, with two white stripes; abdomen blackish, testaceous at the base; femora and tibiae with black tips; tarsi black, testaceous toward the base; wings vitreous; veins pale testaceous. Length of body 2mm; of wings 4½mm. Mexico.

This species can hardly be the female of S. metallicum Bellardi.

S. pecuarum Riley

U. S. Dep't Agric. Rep't for 1886. 1887. p.512 (Coquillett considers this a synonym of S. invenustum Walker)

Plate 33, fig.6–11

Female. Length 2.5mm to 4mm. Head uniform grayish slate, clothed with short yellowish hair, which becomes longer behind the eyes; eyes black, with coppery or brassy reflections; antennae black, with whitish pubescence, and with a few bristles on two basal joints, which are tinged with red, joints 1 to 11 gradually diminishing in thickness toward the last, joint 1 the shortest, joints 2 and 3 twice as long as joint 1, joints 4, 5 and 6 as long as joint 1, joints 7, 8, 9 and 10 gradually increasing in length, last joint fusiform, twice as long as joint 10. Maxillary palpi a little longer than the antennae, blackish, with long grayish bristles.

Thorax grayish slate, more or less densely covered with short, yellow hairs, and with usually very distinct markings, consisting of two median dorsal, and two subdorsal broad, longitudinal, sooty black bands, of which the latter curve to posterior edge of patagium, which is reddish at tip; lateral edges of prothorax with fine black sutures; underside of the thorax uniform grayish slate, with sparse yellow hairs, space around the one large stigma lighter; halteres opaque, reddish white; legs uniform reddish brown, densely covered with yellowish hairs; tips of the tarsi blackish; wings subhyaline; larger veins and base reddish brown.

Abdomen nine jointed; joints subequal in length except the last two, which decrease in length; a longitudinal, broad, bluish gray dorsal band extends from near the base of second segment, where it is broadest, to the tip curving downward to the anterior lateral edge of seventh segment; below this band laterally the color is blackish brown, with the exception of a broad bluish gray transverse band on the posterior edge of each of the segments from 1 to 6; underside of abdomen uniform brownish gray, without markings; abdomen densely covered with yellowish hair, which is very long upon the posterior edge of segment 1, forming an overlapping fringe.

Male. Length 1.5 to 2.2mm; differs considerably from the female. Head not visible from above, being occupied by the very large confluent eyes; the remaining parts below the eyes are black, with black hairs and bristles; eyes composed of two different kinds of facets, those above very large, twice as large as those of female, and those in front and surrounding the dwarfed trophi very minute, the dividing line between the sizes being abrupt; antenna similar to the female, more pronounced in color, both the black and reddish being more vivid; maxillary palpi black, and shorter than the antennae. Thorax black above with sparse yellow hairs; legs somewhat lighter in color, tip of the tarsi not black; hairs upon the legs longer than those of the female. Wings hyaline, veins and base yellowish brown. Abdomen black with grayish white posterior margins to the segments dorsally and laterally, and covered with longer yellowish hair. Described from two bred specimens.

Larva. Average length when full grown 7mm to 8mm, subcylindric, the club-shaped posterior third of body being twice as stout as the thoracic joints, and joint 4 the most constricted. Translucent when living, dirty white in alcohol. Immaculate in a very few specimens; distinctly marked in the great majority with brownish dorsal cross bands in middle of joints, leaving free a white mediodorsal longitudinal line. Thoracic joints with three irregular rings of the same color; underside more or less irregularly spotted with brown. Head subquadrate, horny, yellowish brown, with a number of brown spots and lines in regular order, and two roundish, approximate ocellate, black dots on each side under the skin, and seemingly rudimentary organs of sight, from which the future eyes originate. Antennae uniformly pale, three jointed, about one third as long as greatest width of the head; joint 1 very stout, fully four times as thick as 2, which is a little longer than 1, straight, slightly tapering toward the tip. Joint 3 extremely small, a mere triangular tip; mentum subtriangular, with apex cut away, and replaced by three groups of very small teeth, of which the central group consists of three teeth, the middle one largest; and the groups on sides, of four teeth, of which the second from center is largest. Sides of mentum, near the apex, with two small teeth each; all the teeth are chitinous and black; a long erect bristle, pointing upward and inward, near each side of mentum; labrum horny, densely covered with hair; mandibles resembling in shape the profile of the inverted last joint of the human thumb, with a series of teeth in place of the nail. Teeth difficult to see, owing to the presence of five distinct brushes of hair; on extreme lower tip of mandibles three large teeth; below them a series of 11 slender and very pointed teeth, of which the first two are the smallest, teeth 3 to 9 increasing and teeth 10 and 11 decreasing gradually in length; a second series of teeth below them consists of two triangular teeth, of which the first is largest. Maxilla stout, fleshy, with an internal thumb-shaped lobe; maxillary palpus two jointed, first joint cylindric; second very short, crowned with a regular circular row of short spines or warts; labium horny with two brushes of hair above, between which is a very small ligula, covered with a small brush of hairs. Fans, composed of stout stem, bearing about 46 scythe-shaped rays, lined on the inside by very minute, equidistant, erect hairs of equal length. Thoracic proleg, faintly four jointed, subconical, retractile (introversible), very thin and transparent, crowned with about 20 rows of short, sharp hooks, apparently arranged in a circular manner; the hooks, of which 10 are in each row, seem to be movable to a certain extent, and are fastened or hinged to small chitinous rods in the epidermis. Tip of abdomen formed by a subcylindric body crowned with rows of hooks. Breathing organs below these hooks and on the upper side of abdomen; they consist of three short, cylindric, soft and retractile tentacles, which connect with large internal tracheae. In full grown larvae a spot more or less dark is seen on each side of thoracic joint; it is produced by the formation of the coiled breathing tubes of the future pupa.

Pupa. General color when fresh, honey-yellow; prothoracic filaments brown, and the abdomen dorsally also tinged with brown, except a mediodorsal space. All the members have also a fine brown marginal line; prothoracic filaments consisting of six main rays, issuing from the basal prominence and subdivided two or three times, so that in most cases as many as 48 terminal filaments can be counted. Abdominal joints three, four, and five, each with eight well separated, dark brown and anteriorly recurved hooks. The four on each side separated by a mediodorsal space; those on joint 3 less conspicuous than those on joints 4 and 5; joint 6 without armature; joints 7, 8 and 9, and also subjoint less distinctly armed near anterior margin with a continuous dorsal row of very minute posteriorly recurved points; ventrally joints 6, 7, and 8 have each four very minute anteriorly recurved hooks.

Cocoon. Average length 3.5mm. Not completely made and not entirely covering the pupa, but tightly surrounding its larger portion. Shape very irregular, with no distinct rim at the upper edge, which is more or less ragged. The threads composing it are very coarse, and the meshes rather open and ordinarily filled with mud. Not always fastened separately to objects, but frequently crowded together without forming, however, such corallike aggregations as in some of the northern species.

That part which Riley called the labium in the above description, appears to be a combination of labium proper and the hypopharynx. Often in dissection these two parts stick together and appear as one, but with a little care the hypopharynx can always be removed entire. To the above description I may add that the apical pair of bristles of the mandibles [fig. 6] are present, though slender, the labrum and hypopharynx [fig. 7] as in other species; the labium [fig. 8] has the middle tooth trifid, and there are three setae (instead of one, as Riley has it) in each row on the ventral side. The maxillary palpi have a few slender setae and there are also a few on the basal joint [fig. 9].

I find eight abdominal segments plus the anal segment in the pupa [fig. 10], and not nine, as Riley has it. Therefore the eight hooks are on each of segments 2, 3 and 4, and not 3, 4 and 5. Dorsally, on each of segments 5, 6 and 9 is a transverse row of minute caudad projecting spines; 7 and 8 with slightly larger ones. Ventrally, segments 5, 6 and 7 each with four large spines curved cephalad. In the Cornell University collection are four specimens of adults, two males and two females, obtained from Riley.

S. pictipes Hagen

Bost. Soc. Nat. Hist. Proc. 1880. 20:305

1895 S. innoxium Comstock, Manual for the Study of Insects

Male. Eyes very broadly contiguous, the large facets distinctly separated from the small by a horizontal line. Face small, as broad opposite the insertion of the antennae as its length, considerably narrowed below; a deep groove on either side running obliquely to the inferior angle, the median part arched; in color grayish pruinose, or in some reflections almost silvery; antennae situated at about the lower fourth in profile; in color black with a slight pruinosity; palpi black, slender, the first three joints somewhat thickened. Metanotum thinly covered with golden pubescence; in color velvet-black, the lateral margins and a spot running upward and inward from each humerus gray and yellowish gray, but somewhat variable in different reflections. Mesad of these gray humeral spots is a pair of small silvery spots. Pleurae, pectus and coxae, gray pruinose, showing in some reflections the black ground color. Abdomen with eight visible segments, in color deep velvet-black; under the leaflike margins of the first segments and the sides of the remaining segments gray, or in some reflections silvery pruinose. Legs black or dark brown, the basal part of the dilated hind metatarsal joint yellow, in some specimens the extreme base of the tibiae yellowish, with a single short spur on the fore tibiae, and a pair of longer ones on middle and hind tibiae [pl.38, fig.8]. Fore and middle tarsi slender, hind ones widened, all claws trifid [pl.38, fig.8, 17]. Wings hyaline or slightly tinged; the anterior veins thickened, the remainder slender [pl.36, fig.7]. Knob of halteres orange yellow. The male genital organs are short though rather complex, consisting of a pair of outer sheaths, then a pair of elongate blunt processes, within which are two pairs of hooks; the outer, shorter pair are incurved and clawlike; the longer, inner pair are slender, with some outwardly projecting hooks. Length 3.5 to 4mm.

Female. Eyes with a small deep sinus on each side, just about the base of the antennae, above which the front is a little longer than wide, and a little wider above than below. Face a little wider than the narrow part of the front, the sides parallel, its surface gently and evenly convex, clothed with white hairs; antennae tapering more than in the males, the first two joints yellowish. Basal joints of palpi stouter. Facets of eyes uniformly small, the eyes much smaller and the posterior orbits conspicuous. Thorax like the head, opaque gray pruinose. Metanotum with three slender, deep brown or black stripes, the lateral ones gently incurved back of the anterior knoblike dilation. Abdomen velvet-black, the second segment (or the part beneath the leaflike margins of the first) and the posterior margins of three following segments (except at the center), opaque gray or grayish white; the remaining segments, and leaflike sides of the first, lightly pruinose; venter gray; in some specimens with a small black or grayish triangular spot on center of the dorsum of segments 3, 4 and 5. The legs grayish, in some specimens quite pale; the tips of some or all the tibiae usually, and the tarsi nearly always, black, except the bases of hind metatarsi and sometimes the middle also, which are yellow. The tibial spurs and hind metatarsi as with the male. Tarsal claws simple [pl.38, fig.20]. Wings as with the male. Knob of halteres yellowish white. Length 3 to 4mm.

I have compared this species with Hagen's type, (larvae, pupae and adults) and find that they agree perfectly. The apparent discrepancy in comparing Hagen's description[1] with the one given above is due to the fact that Hagen described his from bottled material. His description agrees very well with alcoholic material of this very common Ithaca species. Hagen was in error in regard to the number of respiratory filaments of the pupa, in stating that there were but eight; for, on examination of the Cambridge material, nine filaments were counted. Coquillett (1898) says of the male mesonotum, "usually with three black vittae"; but this I have found to be an exception rather than a rule.

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[1] Bost. Soc. Nat. Hist. Proc. 20:305.

Recorded from New York, Texas, California, and Moscow Id. (Collected by Aldrich).

Larva. Length 10 to 12mm. Plate 36.

The fans of this species have about 60 rays; the cilia and the regularly arranged setae on the inside of the rays are very distinct. The antennae, light brown in color, are three jointed, the second joint about one third as long as the first, the third very short and pointed, the extremities of the first and second are hyaline, the two small budlike processes at the end of the first and the second joint are brown. The mandibles possess the apical pair of bristles, the apical teeth are quite black, the others paler; the maxillary palpus with a few scattered bristles on the shaft and at the base. Labrum and hypopharynx as usual, in the latter the lateral hornlike processes are quite prominent. Labium with the toothed area rather narrow, the lateral and middle teeth elongate, the ventral surface with two rows of 10 or 11 bristles each [fig.3]. The thorax and abdomen are a deep black; paler at the incisures, and on the ventral surface, particularly toward the caudal end. A narrow black longitudinal, ventral stripe is often present. The blood gills consist of three many branched papillae.

Pupa. The two thoracic respiratory organs each consist of nine filaments; eight of which are about equal in length, the ninth arises a little lower on the shaft, and is somewhat shorter [fig.8]. On the dorsal surface of each of the segments 2, 3, 4, and 8, are eight black hooks curved cephalad, those on the second and the eighth segments being much smaller than the others. Ventrally 5, 6 and 7 each, with four double, curved hooks, on the caudal segments are two very short blunt spines, and three smaller ones on each side of 3, 4 and 5. The pupal case is of the boot-shaped type [pl.35, fig.5].

S. pulchrum Philippi

Chilian Diptera. 1865. p.633

1896 S. tarsale Williston, Dipt. of St Vincent, p.268

Female. Abdomen black, the proximal segments opaque, the distal four segments shining. Length 2mm.

Front and face black, with a light gray reflection. Antennae yellow; the distal joints somewhat brownish. Mesonotum deep black; in front, opaque with a silvery shimmer, and with sparse, short, curly, golden yellow tomentum; behind, shining. Pleura black, whitish pruinose. Abdomen black, the basal segments opaque, the distal four segments somewhat shining, and with a delicate whitish pruinosity. Legs reddish yellow; tarsi black, except that the proximal half of the middle and hind metatarsi is light yellow; first and third joints of the front pair each with two long hairs; second and third joints of the same pair dilated, the fourth and fifth very small; hind metatarsi elongate and stout, the following two joints a little dilated, the fourth and fifth small. Wings hyaline; veins yellow. *Williston*

Three specimens. The above synonymy is according to Hunter.

This species seems to resemble greatly S. venustum excepting for the color of its legs.

S. quadrivittatum Loew

Berl. Ent. Zeitschr. 1862. Centur. 2, p.186

Black opaque, the thorax with four white vittae; the halteres yellow; middle and hind tibiae and tarsi white banded; wings hyaline. Body 1.67mm; wing 1.67mm.

Black, opaque. Antennae fuscous; dorsum of the thorax with four longitudinal lines, the posterior margin whitish pollinose; scutellum spotless; the pleural spots and the metanotum whitish pollinose; the legs fuscous black; the knees and the bases of the metatarsi of the fore legs, the basal rings of the middle and hind tibiae, the metatarsi excepting the tip, and the bases of the second and third tarsal joints are white; halteres yellow; wings hyaline, the heavier veins deep yellow. Cuba.

S. reptans Linnaeus

Fauna Suec. 1803. 1761 (Synonymy according to Schiner, 2)

1767 sericea Linnaeus, Syst. Nat. 12:978, no. 58
1776 erythrocephala DeGeer, Ins. 6:161, no. 37 (Tipula)
1781 reptans L. Schrank, Enum. Ins. Austr. p.985 (Culex)
1804 argyropeza Meigen, Syst. Beschr. 1:291-92
1818 reptans Meigen, Syst. Beschr. 1:291-92
1818 sericea Meigen, Syst. Beschr. 1:296-98
1818 elegans Meigen, Syst. Beschr. 1:296-99
1818 variegata Meigen, Syst. Beschr. 1:292-93
1823 reptans Fries, Obs. Entomol. Pars 1 Monogr. Simul. 1:13
1830 cincta Meigen, Syst. Beschr. 6:311-14
1838 posticata Meigen, Syst. Beschr. 7:52, 21

Male. Velvet-black; dorsum of the thorax with a silvery white margin, spotlike on the humerus, broadly interrupted in front;

visible only in certain lights. Pleura also with a whitish reflection; abdomen with silvery white spots on the second and on the last two segments, wanting in rubbed specimens; the posterior margin of the first segment with long and dense brownish cilia. Head black, face grayish white; antennae and palpi brownish black, the former more slender than is usual with the members of this genus, with whitish reflections on some parts. Legs dark brown; front coxae yellowish, fore tibiae silvery white outwardly; middle tibiae yellow at the base, hind tibiae likewise, though in less degree, light brown, with a whitish reflection; metatarsi of the hind legs yellowish at the base; the hairs of the fore and hind femora, and particularly on the extensor surface of the hind tibiae, conspicuous. Halteres bright yellow; wings purely hyaline, with delicate and transparent veins, those of the anterior margin being somewhat thicker and more conspicuous; the wing surface with a golden brown reflection; the media not petiolate. The short, scattered hair of the thorax seldom distinct, the color of the legs variable in intensity.

Female. In coloring does not resemble the male in the least. The ground color is blackish brown; the dorsum of the thorax covered with a depressed yellow pile, on the margins with a whitish reflection, on the center with a grayish reflection, the pleurae grayish white. Abdomen somewhat shining; on the sides whitish or yellowish gray; on the venter, at least at the base, in living specimens, yellow, which is continued around on the dorsum in some specimens, usually not distinct in dried specimens. Legs brown, usually paler than those of the male; the tibiae, with the exception of the tip, and the fore coxae whitish or yellowish white, the tips of the tibiae and the tarsi black, the basal half of the hind metatarsi and sometimes also the extreme base of the following joint yellowish. Front and face gray; antennae and palpi brown, the former paler at the base. In other particulars as with the male. Length 2 to 3mm. Translation from Schiner, *Fauna Austriaca*, 2:365

According to Schiner [*loc. cit.*] this is the species whose life history has been described by Fries, Westwood and Heeger. According to Schiner also, sericea is a synonym of reptans. Of sericea Westwood writes that the larva possesses three unbranched blood gills, and that the pupa has eight thoracic respiratory filaments on each side.

This European species has been reported by Lundbeck as occurring in Greenland. (Diptera groenlandica, 1898)

S. tamaulipense Townsend

N. Y. Ent. Soc. Jour. 1897. 5:171–72

Female. Length 1.5mm. Near S. meridionale, but smaller, and the outer one on each side of the three thoracic lines not curved outward at posterior end. Eyes velvet-black, face and front silvery; front with usually a trace of a linear black vitta, in one specimen very distinct, in another entirely wanting. Antennae yellowish with a silvery covering. Thorax silvery, with three longitudinal lines; middle one longest, very narrow and linear; outer ones heavier, straight, slightly divergent posteriorly. Looked at directly from above, the outer lines appear curved, outwardly convex. Scutellum and metascutum below scutellum, both brownish in some lights but in others they appear wholly silvery, the various portions appearing different in color to the view at the same time. Abdomen silvery but the third and fourth segments wholly brownish, sometimes with a round median spot on each. Legs yellowish, shaded with silvery, tarsi blackish or brownish; hind metatarsi yellowish except at distal end. Wings clear, whitish, veins dilute yellowish. Halteres and wing bases pale dilute yellowish.

Four females, Reynosa, Tamaulipas. A small species taken on the windowpane of railroad car, May 4. Described from four dried specimens. *Townsend*

S. venustum Say

Acad. Nat. Sci. Phila. Jour. 1822. 1:28 and Compl. Wr. 2:51

1862 molestum Harris, Ins. Inj. to Veg.
1870 piscicidium Riley. Am. Ent. 2:367

(Synonymy according to Coquillett, 1898)

Male. Velvet-black. The eyes are very large, separated by a single line, reddish yellow, lower half black. Thorax velvet-black, a bright pearlaceous, dilated line each side before, and a large pearlaceous spot behind, sides beneath varied with pearlaceous. Abdomen with an oblique pearlaceous line at base, and two approximated lateral pearlaceous ones near the tip. Tibiae above, and first joint of four posterior tarsi white. Wings with yellow and iridescent reflections. Poisers black, capitulum bright yellow, dilated. Near Louisville Ky. at Falls of the Ohio. *Say, loc. cit.*

Superhumeral gray stripes metallic, no metallic spots between them; mesonotum not vittate with black. *Coquillett*[1]

The following description of the males is based on specimens from Ithaca N. Y. and Battle Creek Mich. Velvet-black. An-

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[1] U. S. Dep't Agric. Bul. 10, n. s. 1898.

tennae black, covered with short whitish pile; palpi black, thorax velvety black, with an oblique bluish white metallic humeral spot, the posterior margin also metallic; scutellum velvety black; and pectus black, grayish pruinose. Abdomen deep velvety black; on each side on the margin of the first abdominal segment is a tuft of fuscous hairs, underneath which the segments appear metallic. The posterior part of the venter appears metallic. Legs, black and yellow. The extensor surface of front tibiae, and a basal ring on the middle and hind tibiae, silvery white; the fore coxae, basal half of all femora, tibiae and metatarsi, and sometimes also bases of some tarsal joints more or less yellowish; the rest black. The anterior tibia with a rudimentary spur, middle and hind pair each with two spurs; tarsal claws trifid. Halteres orange-yellow; wings whitish hyaline. Length 2 to 2.5mm.

Female. Black. Antennae black covered with short whitish pile; two basal joints usually yellowish; palpi black with pale hairs; face and front gray pollinose. Dorsum of thorax black, bluish gray pollinose, particularly on the sides and front corners, sparsely covered with very short yellow hairs. Scutellum black, with erect black bristles; pleura black, gray pollinose. Abdomen black, the anterior segments velvety, the posterior ones subshining brown. Legs yellowish, middle and hind coxae brown, tips of femora and tibiae, the whole of fore tarsi, tips of the middle and hind, first and second tarsal joints and usually the whole of the remaining joints, black. Sometimes the femora are wholly black. The extensor surface of all tibiae is silvery white. The first and third joints of the fore tarsi are each provided with a pair of long black hairs near the tip, besides the usual shorter ones. The anterior tibia with rudimentary spur, middle and hind ones each with a pair. Tarsal claws simple. Wings whitish hyaline, the heavy veins yellowish brown, quite yellowish at the base at point of attachment. Halteres pale yellow. Length 2 to 3mm.

This species is very common in the Adirondacks, where it proves to be a great annoyance to travelers. It seems to have a wide distribution, having been reported by Mr Coquillett[1] as occurring in Canada, New Hampshire, New York, Michigan, Minnesota, Wyoming, British Columbia, California, Texas, Louisiana, Mississippi and Florida. I have found it in Ithaca N. Y., and I have seen specimens from Moscow, Marsh and Albion Id., and Battle Creek Mich.

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[1] U. S. Dep't Agric. Bul. 10, n. s. 2. 1898.

Larva. Specimens from Wilmuth and Axton N. Y. [Pl.37, fig.1 to 6]. Pale brown with paler incisures; head brown, labrum hairy, with serrated edge; fans with 50 to 60 rays; mandibles with a pair of apical setae; hypopharynx as usual; labrum [fig.6] with middle tooth rather prominent, its ventral surface with five setae in each of the two rows; each of the three branches of anal papillae with a number of lobes.

Pupa. Six branched respiratory filaments; eight hooks curved cephalad on dorsum of each of abdominal segments 3 and 4; four hooks curved cephalad on ventral surface of each of segments 5, 6 and 7; a close transverse row of small caudad projecting spines on dorsum of eighth segment, and a pair of short, blunt tubercles on the anal segment. Cocoon of the wall pocket type.

S. venustum, var. a

Plate 37, fig.8–14

A number of specimens bred from larvae and pupae taken from Fall creek, Ithaca N. Y., differ in the adult stage from venustum as described above in being uniformly smaller (length 1.5mm); having the base of wing brownish and not yellow, and in having the last four abdominal segments of the female a shining black instead of brown. The larva differs as follows: in size averaging less than two thirds that of venustum, labrum with its toothed edge wider in proportion to its size than in venustum, its teeth more nearly of a size, the ventral setae three in each row plus a very small one. The pupa differs in having 10 respiratory filaments in each tuft, the hooks on segment 2 more distinct, and the tubercles on the anal segments apparently wanting.

S. piscicidium (Synonym of venustum) Riley

Am. Ent. 2:367

According to Coquillett this is a synonym of S. venustum; but I have larvae and pupae from Professor Needham, taken at Saranac Inn N. Y., which, though agreeing with Riley's figures of piscicidium, differ decidedly from the larvae and pupae of S. venustum taken by Messrs MacGillivray and Houghton at Axton N. Y. in 1901, and by Professor Comstock at Wilmuth N. Y. Of the adults of the Saranac Inn material I have only alcoholic specimens, hence can not state definitely wherein these differ from S. venustum from Axton N. Y. excepting that it averages a little larger in size. For the present I shall regard it as a variety, though in all the material of larvae and pupae studied I did not find transitional characters. Should a difference be discovered on the examination of more fresh specimens of both varieties of adults, the specific name of piscicidium must be revived. Riley's description is as follows:

Female. Head velvet-black; eyes brownish; antennae with joints 1, 2, 3 and 11, subequal in length, each of the others half as long. 1 and 2 rufous, 3 to 11 inclusive black and gradually diminishing in thickness to the last, which is fusiform; palpi longer than the antennae, black. Thorax velvety black with faint fulvous pubescence above; halteres opaque and white. Abdomen nine jointed, joints equal in length except the last two, which are smaller and smaller; dorsally velvety black, laterally and ventrally, especially towards the base and at the incisures, inclining more or less to rufous. Legs with the front trochanters white or fulvous, and the middle and hind ones more dusky; the coxae all either rufous or fulvous; the femora all dark, though sometimes (two specimens) the base is paler. Front tibiae with the upper three fourths white, the rest black; hind tibiae with the upper two thirds white, the rest black; middle tibiae with about the upper one half white, the rest black; front tarsi black; middle and hind tarsi with the upper half of first joint white or rufous, the rest black. Wings subhyaline, with the veins fuliginous. Length of the body (in alcoholic specimens) .14 to .17 inch. Mumford N. Y.—Riley

Larva [pl.37, fig.2,5,7]. Pale grayish, slightly darker dorsally. Head of the usual shape, brown with darker margins. Fans with 50 to 60 rays, the longer cilia quite prominent. The apical pair of bristles of the mandibles present; the labrum with a serrated margin; the maxillary palpus with a few setae on last joint and also on base; hypopharynx as usual; labium with the toothed margin comparatively narrow; its teeth nearly uniform in size, with seven setae in each row on the ventral surface [fig.5]. Anal papillae, three much branched lobes.

Pupa. The pupa with eight branched respiratory filaments, with four hooks curved cephalad on ventral surface of each of the segments 4, 5, 6 and 7, those on the fourth being quite small. On the dorsal surface of each of segments 3, 4, 5 and 6 are eight hooks curved cephalad, those of 5 and 6 being very small; and on the dorsal surface of 7 and 8 are a number of hooks curved caudad. The anal segment with two short, blunt spines. The pupal case is of the " wall pocket " type.

In order to obtain characters to separate the adults of the Fall creek, Saranac Inn and Axton varieties of venustum, a number of them which were nearly ready to emerge were drawn from the pupal skins and examined for distinctive structural characters; but, excepting the difference in size, none were observed. With freshly bred material, perhaps specific characters might be obtained.

The larvae of piscicidium is briefly described by Riley in the paper just quoted.

S. virgatum Coquillett

U. S. Nat. Mus. Proc. 1902. 25:97

Male. Head and body black, antennae and mouth parts dark brown, thorax gray pruinose, mesonotum marked with a narrow median and laterally with a very broad velvet-black vitta (viewed directly from above), mesonotum sparsely covered with short, appressed hairs; abdomen on first six segments opaque, velvet-black, a large silvery white spot on each side of the second and sixth segments, venter near each side with an interrupted yellow vitta on segments three to seven, composed of appressed hairs, on each side of base of abdomen is a large cluster of yellow hairs, and a smaller cluster on each side of segments three to five; femora and front tibiae yellow, their apices brown, middle tibiae brown, a yellow ring beyond the base, hind tibiae brown, the extreme base yellowish; tarsi black, broad base of first joint and extreme base of the second on the middle and hind tarsi light yellowish; wings hyaline, veins along the costa yellowish brown, the others nearly hyaline; halteres yellow.

Female. Differs from the male as follows. Vittae of mesonotum brownish, the median vitta dilated posteriorly, wider than either of the lateral ones; viewed from in front the mesonotum appears whitish pruinose and with two velvet-black vittae; abdomen on the first five segments and sides of the sixth opaque, gray pruinose, and with a velvet-black fascia at bases of three to six, broadly interrupted on six, the middle of which and the portion of the abdomen beyond it is very thinly pruinose and of a dark brown color. Length nearly 3mm. In August; Las Vegas Hot Springs, N. M.

S. vittatum Zetterstedt

Ins. Lapponica. 1844. p.803

(= S. tribulatum Lugger)

(According to Coquillett, decorum Walk. 1848 and argus Will. 1893 are synonyms)

Female. Gray; nearly bare; dorsum of thorax with five black stripes, the median one entire, the intermediate pairs interrupted, the exterior pair spotlike. Each segment of the abdomen with a black dorsal stripe and basally on each side with a black spot, the penultimate segment black. Wings whitish hyaline; halteres white; legs fuscous black, the front side of anterior tibiae, the base of the middle and hind tibiae, and the base of the middle and hind metatarsi white. Length 3mm. *Zetterstedt*

Female. The abdomen gray, bases of segments 3 to 7 or 8 marked with a velvet-black fascia produced backward in the middle and at the ends. Length 2 to 4mm. New York, Minnesota, Nebraska, Kansas, California.

Male. Hind tarsi bicolorous, mesonotum gray on sides and hind margin, center largely velvet-black; without gray streak extending inward from humerus; sides of abdominal segments 4 to 7 with silvery white hairs. *Coquillett*[1]

The markings of the female of this species seem somewhat variable. The thoracic markings are usually quite distinct. The median stripe is nearly of uniform width excepting at the posterior end, where it becomes narrower; the intermediate stripes are ∫ shaped, the extremities larger, the intermediate portion usually a hair line, sometimes obsolete; the exterior pair usually elongated spots. The abdominal markings are as described by Coquillett, though occasionally there are additional disconnected, velvet-black lateral spots, one on each side on segments 3, 4 and 7, and a pair on 5 and 6. Sometimes also, owing either to the contracted condition of the abdomen or to the fasciae being narrow, only the black projections of the fasciae are visible on the more posterior segments, giving the appearance of three spots on each. The legs are often gray; the femora and tibiae paler at the base, the tibiae black at tip, the tarsi deep black except basal portion of middle and hind metatarsi. Fore tibiae with one spur, middle and hind with a pair. Tarsal claws of female simple.

Some specimens from Brookings S. D., received from Professor Aldrich, and which are the males of vittatum, possess the following characters:

Male. Velvety black, antennae and palpi dark brown; dorsum of thorax velvety black with the anterior and lateral margins

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[1] Bul. 10, n. s. 1898. p.63.

narrowly, and posterior margins in front of scutellum, widely silvery gray; also two narrow longitudinal gray stripes on dorsum. Or the dorsum might have been described as silvery gray with three very wide velvety black longitudinal stripes, abbreviated behind. Pleura black, bare; scutellum velvety black; metanotum silvery gray; abdomen velvet-black, the sides of first two or three segments of the ventral surface with a silvery reflection in some lights; legs black, the tips of the fore femora, the basal half of fore and hind tibiae (sometimes the middle one also) the basal two thirds of hind metatarsi, and the extreme base of the second hind tarsal joint, yellow. Fore tibiae with a single spur, middle and hind tibiae with each two; tarsal claws tridentate. Halteres bright orange-yellow. Wings hyaline, the vein yellow. Length, 3mm.

In an article by Lugger[1], it is stated that in S. tribulatum the male is much smaller than the female, having very large brilliant, red eyes that meet on top of the head; the body is velvety black with bright golden yellow and blue spots; the female is gray with black markings. This species is said to be most abundant in Minnesota, where it is called "the black fly." No further description is given; the figures of the male and female agree with the description of S. vittatum. Some specimens sent by Mr Washburn of the Minnesota Experiment Station, labeled S. tribulatum proved to be S. vittatum. I have specimens of larvae and pupae which belong to S. vittatum, which were sent to me by Professor Needham, he having obtained them from Mr J. C. Bradley of Philadelphia.

Larva (of S. vittatum). Somewhat mottled gray, the sides of each segment blackish. The larvae and pupae were collected by Mr J. C. Bradley, Philadelphia, 1901. The head is of the usual reddish brown color; the pale yellow antennae long and cylindric, the second joint about one third the length of the first, the third is a pointed process at the tip of the second. The fans have about 40 rays, the cilia being relatively minute. The mandibles are provided with three large apical teeth besides the row of secondary ones; the apical pair of bristles is present. The maxillary palpus has a few spines, and a tuft of a few spines on the basal joint. Hypopharynx and labrum apparently like those of other species. The labium has an elongate middle tooth, those at the end nearly as long, the intermediate ones short [pl.35, fig.2], and there are six bristles in each of the two longitudinal rows on the ventral surface. The three blood gills at caudal end are unbranched.

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[1] Minn. Agric. Exp. Sta. Bul. 48, p.207.

Pupa. The thoracic respiratory filaments each consist of a single main trunk, from which arise eight branches, each of which divides into two, thus making 16 twigs in all [pl.35, fig.1]. Near the basal margin of the last few abdominal segments, are a few caudad projecting dorsal hooks, and on the tip of the last segment is a pair of blunt spines. The pupal case is of the wall pocket type, from which the respiratory filaments of the pupa project. Judging from the number of respiratory filaments of the pupa, the species described by Osten Sacken in *American Entomologist*, volume 2, seems to belong here.

Simulium sp. C. H. Townsend

Am. Ent. Soc. Trans. April 1893. 15:45

The larva and pupa of a species which appears to differ from S. var. piscicidium, are described by Townsend [*loc. cit.*], the only species with which it might be confused. Specific characteristics are as follows:

On the dorsal surface of the head are several rows and groups of nearly concolorous markings . . . Antennae pale, nearly as long as one half anterior width of head, three jointed, first joint very elongate, and narrow, not swollen, slightly curved, with a somewhat faint transverse suture on basal two fifths, cylindric below suture, beyond the suture very slightly and somewhat irregularly narrowing to tip; second joint narrower than tip of the first, straight and of equal width except slightly widened at base, a little more than one third as long as first joint, and with two small, triangular budlike processes, one on each side at the base, springing from the junction of the two joints and approximated to the second joint; third joint extremely small, short, minute, triangular, but little longer than wide, about the same shape as the minute processes at base of second joint. Fans consisting of about 60 scythe-shaped rays each, microscopically thinly hairy . . . Mandibles furnished with teeth on inner side at apex; four large teeth on apex, nine or 10 teeth behind these, gradually decreasing in size, except that the second of these is larger than the first, a large tooth still behind these; with a small one directly beside it . . . Thoracic proleg with at least 30 obliquely longitudinal rows of hooks, and probably more; at base of these there is a marginal transverse row of bristles on side toward body (the leg being flexed forward) extending around laterally, but wanting on outer surface . . . Blood gills a soft, retractile, primarily three branched organ just anterior to these on dorsum, each branch being subdivided into five smaller branches or papillae. Length 11–13mm. Width of head about 1mm. Of anal portion $1\frac{3}{5}$mm. [The figure given by Townsend shows the mandible with the apical bristles.]

Pupa. General color pale brownish yellow on the thoracic portion, abdomen darker; head, wing and leg cases, and filaments pale yellowish, the head sometimes brownish; prothoracic filaments arising from a single stalk on each side, which branches at base into usually eight filaments; these do not subdivide. Third and fourth abdominal segments with five or six brown hooks or spines on posterior margin of dorsum. Length excluding filament, 4.5mm.

Cocoon or case. Massed in coral-like aggregation. Open at top but enveloping all of the pupa, except the filaments or the extreme anterior portion of the hunchbacked thorax. Length 4mm. Abundant in a small stream in one of the branches of Grand cañon. July 8–11, 1893. This branch or side cañon, is one down which the Hance trail leads, being situated about 55 miles in a straight line n. n. w. of Flagstaff Ariz.

Some larvae which I received from Professor Needham, to whom they were sent by Professor Cockerell from Las Vegas N. M., may belong here. The general color however is reddish and it is only about 7 or 8mm in length. The labium has a more irregular outline than most of the other species [pl.35, fig.10]. The mandibles have a pair of apical bristles; labrum, hypopharynx, and mandibles resemble those of other species; on the head are six blotches arranged symmetrically about a median axis; each blotch consisting of two or three confluent black spots.

Simulium, species

Plate 35, fig.4-7

Some specimens of larvae and pupae sent me by Professor V. L. Kellogg, of Stanford University, collected in Santa Cruz mountains, differ from all larvae and pupae so far described.

Larvae. Length 6 to 7mm. Pale brownish gray above, with whitish venter and suture. Head whitish above, the margins brown. The fans with about 30 rays, its longer cilia conspicuous. The secondary fan at the base of the peduncle of the larger fan and usually composed of curved hairs, consists here of coarse, straight hairs. The mandible with apical pair of bristles [fig.6], maxillary palpus with some stout setae, labrum and hypopharynx as with other species. Labium with its teeth nearly of uniform size. Five or six setae in each of the two ventral rows [fig.7]. Anal papillae were retracted in all the specimens examined; hence I could not determine the number. The pupa has 12 respiratory filaments in each tuft [fig.4]. The abdominal hooks, curved cephalad, are as follows: three or four on ventral surface of each of segments 5, 6 and 7; eight on the dorsal surface of 3, 4 and 5; and a pair of very short, blunt tubercles on the anal segment. The pupal case is shaped as shown on plate 35, figure 5.

Family CULICIDAE

Mosquitos

The Culicidae, or mosquitos, have been studied and described by Dr Howard, Mr Coquillett and others in this country, and by Theobald, Ficalbi, Ross, Nuttall, Shipley, Grassi, and others in Europe in such detail that it is unnecessary to repeat here that which has already been done. I shall therefore content myself with merely giving a synopsis of the generic characters of the larvae, pupae and adults, and describing a few forms such as have come under my notice, together with figures illustrating details of structure. An extensive bibliography is given by Ficalbi in Bullet. d. Soc. Ent. Italiana, 1896, to which the reader is referred. Nuttall and Shipley, in the *Journal of Hygiene*, 1:75, give a bibliography of the more recent work. I shall therefore give only a few references to articles which occur in American literature and a few of the more important of the works of Europeans.

Brief bibliography of the biology of the Culicidae

Coquillett, D. W. (1900) Table to the genera and species in U. S. Dep't Agric. Cir. 40, ser. 2, bul. 25, n. s., and table in Howard's book, Mosquitos (1901).

Dyar, H. (1901) Life History of Uranotaenia, and Descriptions of the Larvae of Two Species of Culex and One of Aedes. N. Y. Ent. Soc. Jour. Dec. 1901.

—— (1902) Illustrations of the Larvae of North American Culicidae. 2, 10:194 and 3, 11:23. N. Y. Ent. Soc. Jour.

—— (1902) Notes on Mosquitoes on Long Island N. Y. Ent. Soc. Wash. Proc. 5:45.

—— (1903) Notes on Mosquitoes in New Hampshire. Ent. Soc. Wash. Proc. 5:140.

Ficalbi, E. (1899) Venti specie di Zanzare. Soc. Ent. Italiana Bul.

—— (1896) Rev. sistematica d. fam. delle Culcidae Europee. Soc. Ent. Ital. Bul.

This contains an extensive bibliography.

Giles, G. M. (1900) Gnats or Mosquitoes; a compilation of the descriptions of the mosquitoes of the world.

Howard, L. O. (1900) U. S. Dep't Agric. Cir. 40. ser.2

—— (1900) U. S. Dep't Agric. Div. Ent. Bul. 25, n. s.

—— (1901) Mosquitoes. McClure, Phillips & Co.

This gives the most complete account we have of the biology of mosquitos.

Meinert, F. (1886) De eucephale Myggelarver. in Vidensk. Selsk. Skr., 6. Raekke, naturvidensk. og math. Afd. 3.4.

Contains about 60 quarto pages and two plates on the biology and structure of the Culicidae.

Nuttall & Shipley (1901) Structure and Biology of Anopheles. Jour. of Hygiene, 1:75.

Osten Sacken, C. R. (1868) Am. Ent. Soc. Trans. 2:47, and Western Diptera, p.191 (1877)

Smith, J. B. (1902) Ent. News. 13:268 and 299.

—— (1902) N. Y. Ent. Soc. Jour. 10:10.

Theobald, F. V. (1901) Monograph of the Culicidae. 2v.

With atlas of 37 colored and 5 photographic plates.

Weissmann, A. (1866) Die Metamorphose der Corethra plumicornis.

Also papers in the reports of the various state experiment stations, by Lugger, Osborn, Herrick, and others.

The mosquitos are small to medium sized flies, characterized by the projecting proboscis (sometimes lobed) and by the plumose antennae of the male. The head is small, round; eyes reniform, and ocelli are wanting. The antennae are threadlike, composed of 15 joints, counting the disklike base; the first joint is thick, the following joints small, round and beset with whorls of hairs, forming in the male a long, dense plumosity; the last two joints in the male are slender and bare, or nearly so. The thorax is ovate, arched, but not projecting over the head, without transverse suture, scutellum narrow; metanotum arched. Abdomen long and narrow, somewhat flattened, composed of eight segments; male genitalia prominent, ovipositor short, legs long and slender, the coxae not elongated; the tarsi long. Wings long and narrow, with numerous veins; the hind margin fringed, the costal vein extending all around the wing, and in all known American forms the veins are covered with scales. Venation as in the figures.

The larvae are known as "wrigglers." The head is fully differentiated and usually has eyes; the mouth is usually thickly ciliated with hairs, by means of which a current of water is produced that brings little particles of food within reach. At the posterior end of the body is usually a single breathing tube, or there are two tubes opening to the exterior on the dorsal surface of the last segment. The segment behind the head is without prolegs.

The pupae are free swimming, and very active. The breathing tubes are situated at the sides of the thoracic segments. The abdomen terminates in two leaflike appendages, that act as propellers; but in general the pupae remain near the surface, except when disturbed.

KEY TO GENERA OF CULICIDAE OF THE NORTHERN STATES

Larvae

1 The last abdominal segment with a single dorsal breathing tube, through which may be seen a pair of large tracheae........(4)
Last segment without long breathing tube........................(2)
2 Last segment dorsally with a flat area in which may be seen two spiracles ....(3)
Last segment usually with hooks, no spiracles apparent. Larva transparent, glasslike..........................Corethra
3 Large species with the anal segment bladderlike. Mandibles strongly developed [pl.41, fig.1]........Pelorempis, gen. nov.
Species of medium size with anal segment cylindrical...Anopheles
4 Antennae pendant and ending with four large curved spines. Mochlonyx (Europe)
Antennae not pendant..(5)
5 Antennae fold back against head and terminate in 2 or 3 claws [pl.40] ....Corethrella
Antennae usually only with a few small erect bristles and one or two pointed processes......................................(6)
6 With brush of hairs projecting forward from the mouth............(7)
Brush projects laterad from the mouth. Mandibles long and sharply toothed; large species about 10mm long.......... Psorophora (ciliata)
7 No ventral brush on last abdominal segment......................(10)
Last segment with ventral brush...................................(8)
8 Anal blood gills dilated; lateral comb of eighth segment a single transverse row of spines with elongated bases; anal segment without hair tufts before barred area............ Stegomyia (fasciata)
Anal blood gills slender..(9)
9 Anal blood gills sharply pointed, air tube spines with one tooth; lateral comb of eighth segment a few large spines in a single or partly double row..................Aëdes (fuscus)
Not as above in all respects.................................Culex

10 With two anal blood gills; the two lateral combs of the air tube wanting. Small species; found in water in the pitcher plant .... Aedes (smithii)

With four blood gills; with stellate hairs on the abdomen. Small species .... Uranotaenia (sapphirina)

The southern genera Toxorhynchites, Megarrhinus and Conchyliastes are not included in the above table; their larvae have never been described as far as I am aware.

Pupae

1 Swimming paddles, two pointed lobes [pl.40] .... Corethrella

Swimming paddles rounded .... (1a)

1a The respiratory tube of the thorax spindle-shape, pointed at the apex .... (2)

Tube cylindric or trumpet-shape .... (3)

2 Both inner and outer margins of the swimming paddles with reinforcing ribs, but without spine at the apex .... Corethra

Only the middle rib present; last segment short, seventh segment considerably longer than either the sixth or eighth .... Mochlonyx (Europe)

3 Apex of swimming paddle ending in a small spine .... (5)

Apex with a few cilia or short hairs .... (4)

4 Small species 2 or 3 mm in length; last two segments with a thick brush of hairs on each side... .... Aedes (smithii)

Large species, 7 or 8 mm in length .... Psorophora

5 Large species at least 8 mm in length .... (6)

Moderate or small sized species .... (7)

6 Apex of swimming paddle ending in a short, sharp spine....
Pelorempis gen. nov.

Apparently without a spine (?), with a pair of stellate hairs on the first abdominal segment .... Psorophora

7 Thoracic breathing tubes much elongated, about 12 times as long as wide. Abdomen with a number of stellate hairs..
Uranotaenia (sapphirina)

Tubes not elongate .... (8)

8 Tube about as wide as long .... Anopheles

Tube longer than wide .... Culex

Imagos

1 Proboscis short, not much longer than the head .... (2)

Proboscis elongate, longer than the head and thorax taken together .... (4a)

2 Metatarsus longer than the following joint .... (3)

Metatarsus shorter than the following joint..Mochlonyx (Europe)

3 Species less than 4 mm in length; tarsal claws simple.............. (4)

Large species, 10 or more in length; tarsal claws bifid......
Pelorempis gen. nov.

4 Antennae verticilliate with hairs (i. e. in whorls).. .... Corethra

Antennae wholly covered with hairs, legs densely hairy....
Corethrella

4a Legs bearing many erect scales. Large species.....Psorophora
Legs without these scales..(5)
5 Thorax with metallic blue scales; small species; male with but a single curved claw on the middle leg; palpi of both sexes two jointed and short.....Uranotaenia (sapphirina)
Thorax not so marked..(6)
6 "Hind feet black, their apexes snow white." Male palpi long, in the female short.....................Conchyliastes
Not as above..(7)
7 Palpi elongate...(8)
Palpi short...(9)
8 The fourth fore tarsal joint shorter than the fifth, about as long as wide. Palpi elongate and pointed..........Culex (males)
Fourth fore tarsal, joint longer than wide. Male palpi with enlarged apical joints...........................Anopheles
9 Small species with two jointed palpi; the second joint conical..Aedes
Medium sized species, with four jointed palpi, its apical joint cylindrical ....Culex (females)

Of the southern genera, Megarhinus and Toxorhynchites may be known by their strongly curved proboscis and green and bluish colors. Stegomyia resembles Culex, but has the thorax marked with lines of silvery scales.

Subfamily CORETHRINAE

Genus CORETHRA Meigen

This genus together with Corethrella, Mochlonyx and Pelorempis, nov. gen. forms the subfamily Corethrinae, which is distinguished from the remainder of the family by the comparative shortness of the proboscis. There are but 15 or 16 species in the genus, four or five of which occur in North America. The life history of some of the species has long been known. Some of the works on the biology of Corethra are:

1844 **Staeger.** Naturhist. Tidsskr. I. R. 2. B. 549, 600. Corethra fusca.

1866 **Weissmann, Dr A.** Die Metamorphose der C. plumicornis.

1884 **Herrick, A.** Minn. Geol. Nat. Hist. Sur. p.10. C. appendiculata.

1886 **Meinert, F.** De Eucephale Myggelarver, p.30 to 53. With bibliography.

Generic characters

Usually delicate, moderate sized species of the appearance of a Chironomid, but distinguished by its many veined wing. Head transversely oval, epistome somewhat projecting; proboscis with round labellae, and only one half as long as the incurved, four jointed palpi; antennae 15 jointed, the basal joint disklike, the following joints each thickened at the base, in the male plumose, the last two joints elongated and slender; the eyes crescent-shaped. Thorax highly arched, without suture; scutellum rather small; metathorax prominent. Abdomen long and slender, somewhat flattened, from the base to the middle gradually widening, and again becoming narrower toward the end; hypopygium prominent, the ovipositor projecting. Legs long and slender, the metatarsus longer than the following tarsal joint; claws small and simple. The wing veins and the posterior margin thickly haired; venation as in the figures.

List of the North American species

albipes n. sp. *See* p. 398. Ithaca N. Y.

appendiculata Herrick, Minn. Geol. Nat. Hist. Sur. 1884. p.10. Known only in the larval and pupal stage and may belong to some other genus.

plumicornis Fabricius var. americana. (See subsequent pages for synonymy)
Saranac Inn N. Y., Lake Forest Ill., White mountains, N. H. (Slosson), Minnesota (Herrick)

punctipennis Say, Acad. Nat. Sci. Phila. Jour. 1823. 3:16, and Compl. Wr. 2:43. Wiedemann, 1:14. Pennsylvania and New Jersey.

trivittata Loew, Berl. Ent. Zeit. 1862. p.186. (Centur. 2, 1). Maine, California, Alaska.
This is a synonym of punctipennis according to Giles in his work *Gnats or Mosquitoes*.

The larvae of but three North American species are known. To assist in separating the species which may be found later, I have given in the table the characters of some of the European species also.

1 Antennae shortish and with a spine outwardly; anterior part of the head is spiny; club-shaped bodies at the caudal end instead of claws......................appendiculata Herrick
Antennae with four spines..(2)

2 Ventral comb of the last abdominal segment with a row of brushlike hairs; each consisting of five to seven bristles (European species)..............................fusca Staeger
Ventral comb consisting of a number of separate feathered hairs [pl.39, fig.6]..(3)

3 The pair of leaflike appendages [pl.39, c. fig.4] lying cephalad of the labrum (*l*), at least one half as wide as long; ventral comb of the last abdominal segment with 25 hairs.................(4)

Appendages over the labrum lanceolate and four or five times as long as wide, ventral comb of last segment with 21 hairs (European) .... pallida

4 "One of the four antennal bristles markedly shorter than the rest" .... plumicornis (Europe)

The four antennal bristles of equal length; anal segment with four dorsal hairs .... plumicornis, var. americana

The larva of C. trivittata described by Dyar in N. Y. Ent. Soc. Jour. 10:201 is said to have but 2 dorsal hairs on anal segment.

Pupae

"Extraordinarily elongate abdomen which terminates in two paddlelike appendages, loosely ciliate outwardly" .. appendiculata

Abdomen of moderate length, see figure; paddles with short cilia on the inner margin .... plumicornis

Imagos

1 Wings with dark markings .... (2)

Wings unmarked .... (4)

2 Wings with several cross bands. Length of insect 1.5mm .... Corethrella brakeleyi

Wings with numerous dark spots .... (3)

3 The apex of both femora and the tibiae, and the base also of the tibiae, black, antennae with subfuscous hairs. Length 4.5mm .... trivittata

Legs punctate with numerous small brown spots. Antennae with yellowish hairs .... punctipennis

4 Yellowish white species; legs white and spotless .... albipes n. sp.

Pale brown or reddish yellow species .... plumicornis

Judging from the description, the larva of appendiculata differs greatly from all the known Corethra larvae, and F. Meinert in *De eucephale Myggelarver* says in regard to its pupa that the figure given by Herrick resembles that of a Chironomid rather than a Corethra. In the same paper Meinert expresses the opinion that fusca is but a darker variety of plumicornis; and attributes the differences in the larva to an error of Staeger, assuming that the latter described some other species.

Corethra appendiculata Herrick

Minn. Geol. Nat. Hist. Sur. 1884. p.19, pl.5.

The adult not bred. Larva as follows:

Form is more slender than plumicornis. The tracheal vessels are of a different form and color, and viscera have obvious differences. . . Shape of the head is slender and attenuated toward insertion of the antennae. Antennae are shortish and have a spine outwardly. The cuticular appendages have an unusual form, as has the labrum. The anterior part of the head is spiny. The armature of the end of the abdomen is peculiar. The posterior rudimentary appendages are of a different form, and the claws are replaced by club-shaped bodies. A curious appendage below is indicated in the name. The pupa has an extraordinarily elongate abdomen which terminates in two paddle-shaped appendages, loosely ciliate outwardly. From Lake of the Isles near Minneapolis Minn. *Herrick* [*loc. cit.*]

Corethra plumicornis Fabricius

Plate 39

Ent. Syst. 1794. 4:246-58

The following synonymy is according to Schiner, *Fauna Austriaca*, 1864. 2:624.

1776 cristallina Degeer (Tipula), Ins. 6:149, 20
1787 pilicornis Fabricius (Tipula), Mantissa Ins. 2:325-49
1788-93 hafniensis Gmelin (Tipula), Syst. Natur. 2826, 108
1794 plumicornis Fabricius, Ent. Syst. 4:246-58
1809 (?) lateralis Panzer, Fauna Ger. 109:16
1818 plumicornis Fabricius, Meigen, Syst. Beschr. 1:15. 1
1864 plumicornis Fabricius, Schiner, Fauna Austriaca. 2:624

C. plumicornis, var. americana

Male. Reddish brown; abdomen yellowish; the antennal joints yellow with brown tips, basal joint brown; the hairs pale brown; the front, the upper surface of the proboscis, and the palpal joints brown; the incisures of the latter yellow, the vertex, the cheeks and the underside of the proboscis and neck pale yellow; thorax pale brown above with three dark reddish brown stripes, the middle one divided by a fine, pale brown line; the lateral stripes abbreviated anteriorly, the median one posteriorly; the pectus and the margins of the pleural and jugular sclerites reddish brown; scutellum pale brown, metathorax dark brown; abdominal segments subequal in length except the first and last, which are less than one half of the others. The dorsal surface is brown with pale yellow incisures. The brown coloring is darkest anteriorly, gradually becoming paler candad, so that the posterior margin of the segment is almost as light in color as the incisure. This is particularly true with segments 3, 4 and 5. On segment 6, 7 and 8 the brown color is almost wanting excepting a triangular lateral spot which is prolonged caudad in a fine line. The outline of this spot, however, is not distinct, but is blended in with the color of the dorsum. A pair of very small pale yellow spots with a narrow brown border are more or less distinctly visible on each segment. The hypopygium consists of two jointed hooks, is pale brown in color, nearly as long as an abdominal segment [fig.8]. Venter and the legs are pale yellow, the last two or three tarsal joints slightly infuscated. Legs and abdomen densely but delicately haired; wings yellowish, the veins scarcely dark; venation as in figure 10; halteres pure white. Length 5½mm.

Female. Differs from the male in the following particulars. Antennae entirely yellow, basal joint, palpi and upper surface of proboscis with a tinge of brown; frontal spot brown; scutellum with a fine median line and its posterior margin pale yellow; abdomen yellow, dorsal surface with a tinge of brown, specially on the posterior margin. The two little white spots with pale brown margins also present on each segment. Anal segment brown, genitalia yellow, venter, legs, halteres etc. as with the male. Wings as in figure 9. Length 5mm. Described from alcoholic specimens. New Jersey, Illinois, New York, Minnesota.

Larva differs from Meinerts description [*loc. cit.*] of the European plumicornis in the following particulars. The four long bristles of the antennae are of equal length, while in the European form one is distinctly shorter than the rest; the head in all alcoholic specimens is more sharply constricted from the thorax. In Weissmann's figure the spines of the antennae are shown of equal length.

The larva is colorless, in alcoholic specimens pure white; the large eyes, the pair of air sacs in the thorax and in the seventh abdominal segment are black and the tips of the mandibles brown. The head is somewhat elongate, subconical, the antennae pendant [fig.4*a*], each with four long bristles of equal length. Caudad of these are 10 filaments, five on each side of the median line [fig.4*b*]; these are the filaments of the third metamere of Meinert. Then comes the pair of leaflike appendages, appendages of the third metamere of Meinert, [fig.4*c*]; following which is the labrum.

The labrum [fig.4*l*] is an elongate fleshy, fingerlike process, terminating in several tufts of hair. The two ventral tufts each with from 20 to 25 coarse hairs. At the base and somewhat cephalad of the mandibles [fig.4*m*] are the fans [*f*] each consisting of from 18 to 22 long, coarse hairs. The mandibles [*m*] have four or five teeth, two stout spines anteriorly, and a serrate posterior margin. Closing in the lateral posterior margin of the mouth are the maxillae [fig.*x*]; fleshy lobes, each with a long, jointed appendage anteriorly and two short stout spines. At the posterior border of the mouth is the labium [*l*] with two short spines. The thorax is cylindrical, of greater diameter than the abdomen; the two black air sacs distinctly visible. The abdomen is of circular cross section, tapering gradually toward the caudal end. Segments are subequal in length except the first, which is somewhat shorter; each provided with a few short hair tufts. The black air sacs of the seventh segment are large and distinct. On the ventral surface of the anal segment [fig.6] is a fan of 25 long, feathered hairs, arranged on a keel or ridge. At the apex of this segment are four elongate blood gills and four long, feathered hairs, and near the apex, arranged in a transverse row on each side, is a comb of about 15 small, short hooks, curved cephalad; attached to the base of each hook is a delicate transparent, sickle-shaped blade, with a serrate inner margin; the surface of the blade is covered with transverse ridges, which give it the appearance of a curved pectinate hair, owing to its transparency. The combs are difficult to see. Ventrad of the combs is a pair of large blunt hooks curved cephalad.

The pupa [fig.2] resembles that of Culex, pale yellow in color, the thorax with three brown longitudinal stripes, the middle one divided by a yellow line. Eight abdominal segments are present, the first and eighth shorter than the others, and on each are found a few scattered hairs. Attached to the eighth segment are the swimming paddles [fig.5]; these differ from those of Culex in having, besides the median rib, each margin also supported by a rib. On the inner rib is a row of cilia. The breathing trumpet [fig.20] is spindle-shaped, covered with a close network of pentagonal and hexagonal figures. The small aperture is at the apex.

Corethra punctipennis Say

Acad. Nat. Sci. Phila. Jour. 1823. 3:16. and Compl. Wr. 2:43. Wiedemann. 1828. 1:14

Whitish; wings and feet punctured with fuscous. Inhabits Pennsylvania.

Hair of the antennae yellowish white, the centers of the whorls being fuscous; the shaft of the antennae has a decidedly annulated appearance; eyes black; thorax with three pale yellowish brown abbreviated, broad lines, the middle one originating before and terminating at the center of the disk, the lateral ones originating rather before the middle; feet with numerous small brown punctures; wings with many very obvious brown spots.

Size of C. culiciformis Degeer (i. e. 6mm)

Corethra trivittata Loew

Berl. Ent. Zeit. 1862. Centur. 2, p. 186

Male. Pale yellowish, with three thoracic stripes, the metanotum, fasciae of the abdomen, with apical rings of the femora, and basal and apical rings of the tibiae, fuscous black; the wings with cinereous spots. Length 4.3mm. Wing 5mm.

Pale yellowish, with long, mostly subfuscous pile. Antennae black, annulated, densely verticellate with subfuscous hairs. Dorsum of thorax with three black stripes, the double median one posteriorly, the lateral stripes anteriorly, much shortened. The sides of the scutellum fuscous; metanotum fuscous black; the abdomen fasciate with fuscous. Legs pale yellow; the tarsi from the tip of the first joint pale fuscous; an apical ring on each of the femora and an apical and a basal ring on each tibia is blackish. The wing variegated with some small cinerous black spots. Maine, California, Alaska. (*Osten Sacken*)

This is a synonym of C. punctipennis according to Giles in *Gnats or Mosquitos.*

The larva and pupa of this species are described by Dr Dyar.[1]

The only apparent difference between this and the larva of plumicornis seems to be that in the former species there are but two hairs on dorsal surface of anal segment while there are four in plumicornis.

Corethra albipes nov. sp.

Female. Entire insect pale yellow in ground color; head and antennae wholly pale yellow; dorsum of thorax with three longitudinal stripes pale buff in color, the lateral ones abbreviated anteriorly, the median one posteriorly, the latter divided longitudinally by a pale yellow line. These stripes all narrowly margined with brown, and on the anterior and outer margins of the lateral stripe are a few tiny black specks. Scutellum with a pale buff posterior margin; pleurae yellow, sparsely sprinkled with small, irregular black specks; abdomen yellowish white beneath, pale buff colored above, lateral margin sparsely sprinkled with small irregular black specks; legs pale yellowish, unspotted, fourth and fifth tarsal joints slightly darkened; claws simple; legs and abdomen covered with long, loose yellow hair; wings uniformly pale yellowish, the veins, the hair on them, and the halteres same color. Venation as in plate 39, figure 11. Length 5½mm. Ithaca N. Y. August 1901.

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[1] N. Y. Ent. Soc. Jour. 10:201.

CORETHRELLA Coquillett

N. Y. Ent. Soc. Jour. 10:191

Plate 40

Through the kindness of Prof. John B. Smith of New Brunswick N. J. from whom I received specimens of larvae, pupae and adults, I have been enabled to make a study of this interesting species, which in the adult stage has already been described under the name of Corethra brakeleyi by Mr D. W. Coquillett.

From Corethra it differs in the following particulars:

In both the male and female the thorax, scutellum, abdomen and legs are sparsely covered with long coarse hairs, many of these being as long as the fore metatarsus. The antenna of the male is thickly covered with long hairs arranged all along the shaft excepting on the apical half of the 13th, and all of the 14th and 15th, which have only short hairs. The 15th or apical joint is slightly enlarged and conical [fig.8]. The antenna of the female has a circlet of a few long hairs at the base of each joint and another irregular circlet of somewhat shorter hairs on the middle of it.

In Corethra, at least in those species with which I am familiar, the male has one circlet of many long hairs at the base of each joint, standing nearly at right angles with the shaft. In the female these hairs are fewer and shorter; the second circlet of hairs wanting. In a balsam mount of Corethrella the 15 antennal joints can easily be counted. The eyes are reniform; the palpi and proboscis are short, the former about twice as long as the latter; the metatarsus is longer than the following joint and the tarsal claws [fig.7] are simple and much curved.

Corethrella brakeleyi Coquillett

Larva. The larva resembles that of Mochlonyx much more closely than that of Corethra; it differs from the former in having the antennae attached near the middle line of the head at the extreme cephalic end, hinged so that they move in a horizontal plane, and normally lie folded back against the side of the head, as shown in figure 1 and 2. The head is transversely oval. The antennae [fig.3] have three long curved spines and one very short one at the base. Of the longer spines one is somewhat longer than the other two. The dorsal sclerite of the head [fig.1*d*] is somewhat quadrangular in shape, and is provided at its cephalic end with six setae, the median pair being quite small. The lateral sclerites [fig.1 and 2*b*] are nearly hemispherical, with a small black pigment spot on the dorsal surface near the anterior margin; just cephalad of this is a stout seta, laterad of it is a long slender one, and mesad of it a small irregular area of ommatidia. On the middle of each lateral sclerite, arranged in a single transverse row, are about 12 stout spines projecting cephalad, and immediately in front of this row are two or three long slender setae. At the base of each antenna on the frontal sclerite is another seta.

The labrum is a transversely oval piece [fig.4] which is attached at the cephalic margin of the head and hangs flaplike downward and backward over the mouth; its free end provided with two curved, pale yellow spines, between which are several rows of flattened, short, yellow, forked spines. At the base of the labrum are two pairs of rather long, curved setae, and on the center are two pairs of very short, delicate ones.

The mandibles [fig.2 *md*, 5 *md*, and 6] move in a horizontal plane and when folded down are visible only from the ventral aspect. On the inner (mesal) margin near the apical end is a row of seven stout black teeth; on the dorsoapical margin are two stout flattened spines, which, when the long axis of the mandible is parallel to the body, projects mesad nearly at right angles to the long axis of the body. Also on the dorsal surface, a little apicad of the middle are two unequal long and very stout setae; and proximad of these are seven long and one short lanceolate spine attached to a small crescent-shaped basal piece. When viewed from the ventral surface [fig.5] two slender setae may be observed near the lateral margin.

The maxillae [fig.5*mx*] are two lobed. One is of irregular shape, about as long as wide, articulated at its base, with a seta at the apex, and having a small palpus with three or four pointed processes a little laterad of this seta. On the mesal margin are a number of long stout, setae, and long slender hairs. The second lobe [*mx*, *i*], ventrad and mesad of the first, is elongate with a stout seta on the anterior mesal margin. No suture between it and the head sclerite is visible. It may in fact, be a cephalic prolongation of the lateral sclerite of the head. The labium [fig.5*l*] is immovably joined to the ventral sclerite of the head, no separating suture being visible. Its cephalic margin has about 16 stout black teeth, alternating long and short.

The hypopharynx (not shown in the figure), is tonguelike, and lies immediately dorsad of the labium on the floor of the mouth cavity. It is about as wide as the toothed portion of the labium, its anterior margin provided with a fringe of pale, short, fingerlike processes, which barely project beyond the edge of the labium when viewed from below, and is not visible without dissection.

The thorax [fig.1] is transversely oval, not as wide as the head, with the three segments quite distinct. On the lateral margins of each segment are a few tufts of long laterad projecting setae, those on the second and third segments being longer and more numerous than those of the first, and inserted at the tips of fingerlike processes.

The abdomen [fig.1] is nine segmented with long setae on the margins; the setae of the anterior segments being longer than the posterior ones. The tufts of setae of the first and second abdominal segments are inserted on lobular processes like those of the thorax. The eighth segment is shorter than those preceding it; the ninth is slender and cylindric, and makes an angle with the long axis of the body. At its apex are four small blood or tracheal gills, dorsad of which are a pair of long setae, and ventrad, a tuft of them.

Projecting from the caudal margin of the dorsal surface of the eighth segment is the breathing tube, a cylindric tube, as long as, or longer than any abdominal segment, its diameter being less than half its length. At the apex of the tube are several setae, and triangular flaps to cover the aperture.

The color of the head is brown, that of the thorax and abdomen grayish with white incisures. On the dorsal surface of each abdominal segment, surrounded by the whitish field and caudad of the incisure, is an oval, brownish spot. [*See* fig.1]

Pupa. The pupa [fig.10] resembles that of Culex, but differs from it and from other Culicidae known to me, in lacking the broad swimming paddles. In place of them, there are two pointed processes, each with three spines at the apex and a single one laterally near the middle. The breathing trumpet as in Culex, the plane of the margin being quite oblique, but on the rim of the inner side is a little rounded projection. Each abdominal segment has several pairs of setae, the median pair quite stout, the intermediate pair very short and slender and the one or two laterals long and very delicate. In addition to the laterals, there is a longitudinal lateral fringe of very delicate hairs, and the lateral margin is serrate.

Imago. This has already been well described by Mr D. W. Coquillett; and the description is reproduced below.

In addition to the generic characters which have been pointed out, I may say that the wing is heavily fringed with long hairs. and the veins are covered with scales. The venation is shown in fig.9.

Of the life history Professor Smith has given an account in the *Canadian Entomologist* for 1902.

Corethrella brakeleyi Coquillett

Ent. News. March 1902. p.85

Male and female. Dark brown, the antennae, halteres, knees and tarsi yellow, plumosity of male antennae yellow, mesonotum opaque, gray pruinose except three narrow vittae and a few spots near the humeri, hairs of thorax brownish, those of the abdomen yellow, tibiae and tarsi bearing many long hairs; first joint of front tarsi slightly shorter than the tibia; wings whitish hyaline, marked with a brown cross band near one third and two thirds its length, the first one oblique, the second band produced triangularly near middle of its inner side. costal margin on each side of this band strongly tinged with golden yellow, fringe white, marked with a brown spot at posterior end of each cross band and on either side of the extreme wing tip. Length, 1.5 mm.

One male and three females, bred jointly, Aug. 12 to 14, by Mr J. T. Brakeley and Prof. J. P. Smith, Habitat-Lahaway N. J.

PELOREMPIS nov. gen.

Two peculiar larvae were found in a pail of cold spring water at Saranac Inn by Professor Needham, June 1900. One of them was kept till the fly emerged; the other till it had changed into a pupa. Both the larva and adult differ so much from all the species of the Culicidae that a new genus is necessary to contain it.

Female. Large species resembling Psorophora in general appearance. Head rounded; occiput strongly developed; proboscis a little longer than the hight of the head with rounded labellae; palpi longer than the proboscis, four jointed (not counting the small basal joint [*see* fig. 10, 11]; the two end joints each longer than the preceding; antennae 15 jointed, the basal joint disklike, the second one short and thick, the rest, including the apical one, small, subequal in length, verticillate with a few hairs of moderate length; eyes kidney-shaped, much cut out around the base of antennae, separated from each other on top of head by only a narrow space; ocelli wanting; thorax well arched, transverse suture wanting; scutellum narrow, metanotum well developed; abdomen long and narrow, eight segmented besides the anal segment; genitalia inconspicuous; legs long and slender, with fine short hairs, metatarsus nearly as long as the following four joints taken together; claws slender, each with a single tooth on the under side; wings long and slender, extending almost to the margin of the eighth abdominal segment; the margins, and veins except the true cross veins and the first anal, covered with flattened hairs. Venation as in the figure; anal angle obtuse, posterior lobe prominent and rounded. Halteres free.

Pelorempis americana nov. sp.

pl.41

Female. Antennae when flexed downward reaches just a trifle beyond the outstretched palpi. The upper surface of the epistome is brown, yellowish on the sides, the labrum pure white. The labium, which is somewhat prolonged beyond the labrum is brown beneath; this color extends to near the lobelike tip. The lobes are hemispherical and pale yellow, covered with blackish or dark brown bristles. Black hairs cover both the upper surface of epistome and the under surface of labium, and a few bristles on inner eye margin. The front is pale yellow on the lower part, and brown on the upper; the vertex is brown; back of head yellow; palpi brown, the articulations and all of the last two joints yellow, covered with black hairs; antennae reddish brown, the two basal joints and all of third joint except tip, and bases of all the others pale yellow, its hairs black. Thorax yellowish brown; the anterior margin of thorax, a spot on each side of it, four dorsal stripes, and a spot over the root of each wing reddish brown. The dorsal stripes are wide, the median pair only separated by a fine line much abbreviated posteriorly; the lateral stripes abbreviated anteriorly. Scutellum, pleura, and metanotum yellow, the latter with a triangular spot of brown anteriorly, which is prolonged backward into a fine median line; pectus reddish, or reddish brown; thorax and abdomen nearly bare; abdomen eight jointed plus anal segment, yellow, each segment with a reddish brown fascia which covers the posterior third of the segment, excepting its extreme edge. The anterior margin of each fascia produced forward at the middle and the sides till the brown color nearly reaches the anterior margin of the segment. The anal appendage consists of four rounded, inconspicuous pieces. The venter is paler than the yellow of the dorsum. Legs yellow, a few small spots on the coxae, the tip of all femora, base and tips of all tibiae and the tarsi except the basal one half of the metatarsus are reddish brown. The brown of the tarsi seems to be due to the presence of the numerous brown hairs rather than to ground color. Tarsal claws reddish brown; all tibiae with a single delicate yellow spur; wings with brownish clouds, one on each of the three vein forks, a longer one covering the cross veins; an irregular one covers the bases of the veins and a cloud following the length of the cubitus. All veins with scales except the true cross veins and the first anal; venation as in figures. Halteres yellow with brown margins on knob. Length 10mm.

Larva. The empty larval skin from which the figures on plate 41 were made is in a very good state of preservation excepting for a longitudinal break on the dorsal surface of the head and thorax, and the distorted condition of the skin of the thorax and abdomen. In figure 1 [pl.41] the thorax and abdomen are somewhat diagrammatic and the proportions may not be exact owing to the above mentioned fact; the head and the anal appendages however are drawn to scale. The larva resembles Corethra and Mochlonyx (a European genus) in the form of the antennae, which are elongate, and provided with stout spines, set at an angle with the long axis of the antennae [fig.1, 2]. The spines are three in number, wherein this genus differs from Corethra and Mochlonyx which have four. The mandibles are more highly developed than in the other genera of this family, and possess two stout curved teeth, besides several smaller teeth and spines (ventral view figure 3m; dorsal view figure 5). The fanlike brush of hairs so conspicuous in Anopheles, Culex, etc. and somewhat also in Corethra and Mochlonyx seems to be wanting entirely here. The labrum [fig.6] is trapezoidal in shape, its anterior margin being straight. On its upper surface it is provided with two stout bristles, besides 10 smaller ones arranged as shown in the figure. Two converging rows of scales are present, these reaching the extreme front margin. One of these scales is shown in figure 9. The anterior margin is somewhat ciliated; and on the under surface are two converging rows of transverse chitinous ridges, five or six ridges to each row. The maxillae [fig.3*x*] resembles those of Corethra, its anterior margin provided with numerous scales and hairs. The scales resemble those of the labrum [fig.9]. At the base near the articulation of the mandible is a wartlike prominence with four short spines; this may possibly be the maxillary palpus. Toward the inner margin is a single stout bristle. The epipharynx and hypopharynx are wanting in this specimen, probably torn away when the larval skin was shed. The labium [fig.3*l*] is somewhat triangular in shape, its lateral and anterior margins serrate, six teeth being present in the lateral and 10 in the anterior row. The shape of the head resembles that of Mochlonyx, but with the mandibles more prominent; it is reddish brown in color and heavily chitinized. No eye spots are visible in the specimen.

The thorax is provided with about eight tufts of feathered hairs on each side, the abdomen with about seven pairs. It is possible that several of the more caudad of what is here termed thoracic tufts may belong to the first few abdominal segments. The anal segment and appendages resemble those of Anopheles. The dorsal breathing apparatus [fig.1, 4] shown somewhat flexed sidewise in figure 1, is star-shaped with four radiating pointed lobes, between the anterior pair of which open the two spiracles [fig.4*s*]. At the apex of each of the posterior pair is a single stout bristle. Between the spiracles is a pair of crescent-shaped chitinized brown patches, laterad of which is a pair of small bristles, and another pair is cephalad. The anal segment is ellipsoidal with a row of 31 tufts of hairs, each tuft composed of several hairs; at the caudal end are four (or six) very small blood gills, besides a single large tuft of hairs.

Pupa [fig.8]. This resembles that of Culex and Anopheles. The coloring is like that described for the adult. The breathing trumpets are somewhat less flaring at the top than Anopheles, but more so than is usual with Culex. On the posterior margin of the first segment of the abdomen are three feathered hairs on each side; 2, 3, 4, and 5 each have two feathered hairs on each side plus some scattered hairs; 6, 7 and 8 each have three or four simple hairs on each side. The swimming paddles [fig.7] have a single median rib ending in a short, stout spine.

The venation of the adult wing clearly locates this genus with the Culicidae; the form of the proboscis proves its relationship with Corethra and Mochlonyx, forming with these the subfamily Corethrinae.

Subfamily CULICINAE

This subfamily is characterized by the possession of the typical long proboscis, which is longer than the head and thorax taken together.

Genus ANOPHELES Meigen

Pl. 42, fig. 1–7, 9–11

Moderate sized species resembling the ordinary mosquito. Head rounded, occiput prominent; proboscis bristlelike and projecting forward, longer than the antennae; the palpi in both sexes as long as the proboscis, four jointed, the two end joints taken together shorter than the one preceding, in the male long haired; antennae 15 jointed, the basal joint disklike, the following ones small, in the male long haired, in the female short and sparsely haired; eyes somewhat reniform, the ocelli wanting; the mesothorax rather long and somewhat pointed in front, and without transverse suture; scutellum narrow, the metathorax rather prominent; abdomen long and slender, eight jointed, the genitalia small and inconspicuous; legs long and slender, nearly bare; wings with the veins and the margin thickly haired, the venation as in the figure.

The females may be easily distinguished from Culex by the presence of palpi about as long as the proboscis; the male may be distinguished by the following characters. In Anopheles the last two palpal joints are much thicker than the first and second, and spatulate in form, while in Culex they are the same in diameter, the last one more or less pointed; further, in all the species which I have examined, a stump of a vein extends back into the basal cell from the base of the radial sector and another from base of R_{4+5}; this venation seems to be rare in Culex; in our species also the fourth tarsal joint of the fore leg in Anopheles is more than twice as long as wide, while in Culex it is no longer than wide.

Anopheles punctipennis Say

Acad. Nat. Sci. Phila. Jour. 1823. v.3 and Compl. Wr. 2:39.1

Male. Brown, covered with cinereous hair; head, antennae including the long hairs, palpi and proboscis uniform brown; thorax dark brown with three longitudinal cinereous stripes, the middle one divided by a fine brown line covered with sparse yellow hairs; pleura and scutellum, cinereous brown; metanotum and abdomen dark brown, the latter with the basal two thirds and the extreme posterior edge of each segment with a cinereous bloom, and covered with brown erect hairs; genitalia of moderate size, consisting of two, two jointed appendages, the joints of about equal length, the second one slender, curved and pointed. On the ventral aspect is a sharp caudad projecting spur [fig.10]. Legs uniformly brown except the knees and the extreme tips of the tibiae, which are yellow. The fore tarsal claws have each a long toothed claw and a very short simple one. The feet of the middle and hind legs each have two simple claws. Wings with brown scales, a quadrangular patch of yellow scales just proximad of the fork of R_2 and R_3 covering a short section of both R_1 and the costal vein; an oblique patch at tip of R_1, crossing the media, leaving the tips black of all excepting R_1; a few scattered pale yellow patches of scales elsewhere; and the posterior margin brown scaled, with patches of white ones at the tip of Cu_2. Halteres pale yellow at base, the knob infuscated. Length 3½ to 5 mm, exclusive of antennae and wings.

Female. Brown, as with the male; abdomen more uniformly brown, covered with nearly erect, fine, yellow hairs; scutellum and metathorax with a fine dark line; tarsal claws all simple; wings as with the male but wider in proportion to the length; venation as in figure 5; the basal section of R_4+_5 distad of the R-M cross vein, as the male. Everything else as in the male. Length 4 to 6 mm.

Larva. Three regions may be distinguished in the larva, viz the head, thorax and abdomen. The head is rounded, brown in color, and completely chitinized; the eyes are situated laterally and seem to be of two kinds; one is compact and more or less circular in outline, the other, visible only in older larvae, is a crescentlike body compounded of ommatidia-primordia of adult eyes. On a level with the eyes and cephalad of them are the antennae, and a trifle caudad of the base of these on the dorsal surface, arranged in a transverse row, are six feathered hairs. These are not placed on a band of pigment as is said to be the case with maculipennis. Between the base of the antennae and the base of the maxillary palpi, on a chitinized prominence, is a conspicuous branched hair. Near the tip on the dorsal surface of the labrum are two simple hairs projecting forward; these are more caudad than in maculipennis. Back of the transverse row of feathered hairs is another transverse row composed of four small feathered hairs; between the latter are usually nine more or less distinct pigment spots, the largest in the center, the others arranged around it. At the extreme cephalic end, at each side of the labrum, is a dense brush of brown hairs; another smaller brush is at the tip of the labrum and on the ventral surface of the labrum are several tiny tufts of hairs just in front of the mouth opening. The piece which carries the tufts on the sides of the labrum is called the scutum of the second metamere or clypeus. The antennae are two jointed, the first short and apparently immovable; the second elongate, free, bearing two rather long spines and two short ones, and a six branched hair, (Nuttall shows four in maculipennis). About one third of its length from the base is a branched hair. The mandibles forming the sides of the mouth opening; each possess two stout, elongate, and four or five shorter black teeth at the apex, a little below which is a ridge with a serrated edge (not shown by Nuttall). Overhanging the teeth are three scythe-shaped rays, and between their bases and the base of the teeth are a number of brown hairs and one or more curved spines with a serrated inner edge. Projecting inward from about the middle of the mandible is a fan of hairs, and usually also several branched hairs are to be found on the outer margin.

The maxillae (first pair) each consist of a quadrangular piece with curved hairs on the cephalic, and straight ones on the inner margin. On the inner cephalic angle are several stout setae; the palpus is a conical process covered with short hairs, with three elongate spines at the tip connected by a web, and several shorter bristles. Laterally, near the tip, is a hair having four branches, each branch with several twigs. The maxillae together with the labium (underlip of Meinert) form the floor of the mouth cavity. The labium is a chitinized piece with seven to nine teeth on the cephalic margin, forming a continuation of the ventral wall of the head, to which it is articulated [pl.42, fig.3]. A small toothed piece, in outline resembling the labium but with fewer teeth, lying just inside of the latter, is what I take to be the hypopharynx (not shown in figure). Meinert in his work on Myggelarver [pl.41, fig.24], shows both of these, the one slightly displaced in dissection. The thorax is rounded, its segments obliterated. Twelve long feathered hairs stand on the dorsal surface besides some smaller ones and several simple hairs [pl.42, fig.2]. The nine segmented abdomen is provided with a number of feathered hairs besides many bristles. The first two segments each have two long feathered hairs on each side, the third has one (in all specimens examined); the fourth and fifth on each side, each with three or four simple hairs united at the base, the sixth, seventh and eighth, with but one or two, besides these there are two or three short feathered hairs, and several short, simple ones on each side of each segment. The only difference which I have observed in the hairy armature of the abdomen of this species and maculipennis [figured by Nuttall, *Journal of Hygiene*, v.1, pl.2, fig.4] is the presence of one or two more of the long, simple hairs on the sides of segments 4 and 5. The "palmate hairs" on the sides of 3 to 7 mentioned by Nuttall are also present in this species [pl.42, fig.4*a*]. On the posterior half of the dorsal surface of the eighth segment is the complex respiratory apparatus which surrounds the two stigmata [pl.42, fig.1]. In front of the two stigmata is a brown, apparently chitinized plate, which may be folded over them, flaplike; on each side of them is a conical papilla with a few bristles at the apex. These are not figured by Nuttall though figured by Meinert for C. maculipennis. Prolonged backward are two lobes (somewhat pressed apart in the figure), and between these is an elongate, flattened, checkered plate forming the floor of the area. On the ventral surface of each posterior lobe are a branched hair and a few bristles. On either side of this structure is a comb, its teeth projecting caudad. Each comb has about seven long teeth, and between each of these are from one to four shorter ones. The cylindric ninth segment, when the animal lies horizontal, its dorsal surface uppermost, is suspended obliquely below the breathing apparatus, its dorsal surface covered with a chitinized plate or saddle. From its ventral surface, attached to a keellike process, is a fanlike arrangement consisting of two rows, each with nine branched hairs. On the dorsal surface are four hairs, the two anterior ones are feathered, the two posterior (and also a little more lateral) are branched. The anus is at the extremity of the segment, and surrounded by the four white papillae or blood gills.

Pupa. Resembles that of the other Culicidae. "When viewed sidewise, the pupa of Anopheles presents a comparatively smooth outline, but in Culex the edge where each tergum joins posteriorly the soft integument which unites it with the succeeding tergum stands out as a ridge, and the dorsal outline presents a series of salient angles" [Nuttall & Shipley]. "Respiratory trumpets are not so broad terminally in Culex as in Anopheles" [Howard]. [pl.42, fig.11]

Anopheles maculipennis Meigen

1818 A. maculipennis Meigen, Syst. Beschr. 1:11 Compl. Wr. 1:241

1823 A. quadrimaculatus Say, Long's Exp. Apx. p.356.

1828 A. quadrimaculatus Say, Wiedemann, Aussereur. Zweiflüg. 1:13

Female. Brown. Wings with four fuscous spots. Head, antennae, proboscis and palpi pale brown. Thorax dull cinereous brown, covered with sparse yellow hairs; with two brown lines nearly contiguous posteriorly; pleura cinereous; scutellum and metanotum brown, the latter bare. Abdomen brown, rather thickly covered with suberect yellow hairs, ventral surface paler. Legs brown, the femora pale, knees and tips of tibiae pale yellow. Wings hyaline, the veins with pale brown scales, a spot of darker scales at the base of the radial sector, one at the fork of R_1 and R_2, one at the fork of the media, and a fourth at the cross veins. Venation as in figure 9. The basal section of R_{4+5} proximad of the R–M cross vein. Halteres pale, with a fuscous knob. Nuttall and Shipley state and also show in the figure which they give of the wing of maculipennis that the subcosta extends almost to the tip of the wing. In all specimens of females which I have examined this is not the case with the American form. Should this difference be found constant, Say's name of quadrimaculatus must be restored.

Larva. According to the description and figure given by Nuttall and Shipley [1901], it differs from that of punctipennis in the following particulars. The six feathered hairs arranged on the dorsal surface of the head are placed on a transverse band of pigment. On the dorsal surface of the labrum are two simple hairs projecting forward; these are more cephalad than in punctipennis. The pigment spots arranged symmetrically about the median line, so conspicuous in punctipennis, are wanting in this species. At the end of the second antennal joint is a four branched hair according to the figure given by Nuttall, whereas this hair has six branches in punctipennis. The mandibles show some differences. The only differences in the hairy armature of the abdomen which I have observed in punctipennis, in comparing with the description and figure of Nuttall of maculipennis, is the presence of one or two more of the long, simple hairs of segments 4 and 5 in the former species.

Pupa. Agrees in all particulars with the description given for punctipennis. A comparison of fresh specimens of both species will be necessary to reveal differences.

Genus PSOROPHORA Desvoidy

Large species which resemble Culex in having a straight proboscis; the male has palpi as long as the proboscis, those of the female being short. It differs from Culex in having many nearly erect scales on the legs.

Two species have been described from the United States. They may be distinguished by the characters given in the key below.

Length 6mm exclusive of the probocis; cell 2d R much longer than the cell M; body black, the humeri yellow, pleura and sides of the mesonotum bearing many appressed white scales, abdomen on the upper side covered with appressed violet purple scales, those on the first segment and a few at the hind angles of some of the other segments white. (Hartsville S. C.) Canadian Ent., 1901, p.258..............howardii Coquillett

Length 9 or 10 mm; cell 2d R only a little longer than M [pl.42, fig.8]. Thorax striped; body brown; legs yellow, with dark brown or black erect scales. United States, widely distributed. Wiedemann, Aussereur. Zweiflüg. 1828. 1:13....
ciliata Fabricius

The life history of P. ciliata is given by Howard in the *Canadian Entomologist* for 1900 and also in his work on mosquitos. Of the larva he says, " from Culex it differs in having a longer breathing tube, longer and more pointed blood gills, and the hair fringe on the under side of the anal segment much longer and denser. The jaws are sharply toothed and very long." From the figure it appears also that the mouth brushes project laterally and not forward as in Culex. Figures are given in both of the papers of Howard, mentioned above.

Genus CULEX Linne

The species of this genus are the ordinary mosquitos. In most respects they are like the species of the genus Anopheles, but differ from them in that the male alone possesses the elongate palpi, in the female these are very short; the mesothorax is more arched and more nearly vertical in front; and the hypopygium of the male is quite conspicuous, whereas with Anopheles it is small and inconspicuous. In other respects, including the biting habits of the female, just like Anopheles.

It may be added, that in all species of Culex examined it was found that the fourth tarsal joint of the fore leg in the male is only about as long as it is broad; and that the last joint of the palpus is pointed. The wing venation also appears to present differences from Anopheles, in that the spur at the base of R_{4+5} is usually wanting in Culex.

Larva. The larvae are usually known as wrigglers, and characterized by their rapid wriggling movements, their wormlike bodies and disproportionately large heads with a pair of prominent eyes, an enlarged thorax, and their possessing on the dorsal surface of the eighth segment an elongate breathing tube. The eggs of some species are laid on the surface of the pond or pool in an oblong mass or boat, which in the warmer spring or summer weather hatches within a day or less. The small transparent larvae are extremely active from birth. They come to the surface to breathe, the elongate breathing tube of the last segment being in contact with the surface film, the cephalic end hanging obliquely downward. When disturbed the larva descends to the bottom, jerking its body rapidly from one side to the other. It appears to be heavier than water, for sometimes it may be seen to descend quietly, apparently without motion; though, in order to rise, it "wriggles" to the surface. In the full grown larva the head, more or less rounded, is large, usually nearly as wide as the thorax from which it is separated by a narrow neck. The antenna, which arises from a slight prominence a little in front of the eye, consists of a single elongate shaft, with a short terminal joint (which appears to be annulated), several bristles and jointed hairs at the end of the first joint, and a tuft of hairs at about the middle of the shaft. Projecting from the middle of the anterior end of the head is a complex arrangement of hairs which spring from two folded ridges one on each side of the ventral surface of the labrum [pl.43, fig.5]. The length of the hairs varies with the species. Meinert [*De Eucephale Myggclarver*] speaks of this as a whorl, or rotatory organ, as he believes that it is by the vibrations of these bristles that the food is directed into the mouth. The greater part of the upper surface of the head is formed of a single plate which Meinert [*loc. cit.*] calls the dorsal surface of the third metamere. In front of this is a short, broad plate ("scutum of the second metamere," Meinert), called the clypeus by Giles [*Mosquitoes*]. [pl.44, fig.8*c*]

Attached to the anterior margin of the latter is the round prominence covered with hairs; this is the labium [pl.44, fig.8] or "scutum of the first metamere" [Meinert]. If the front part of the dorsal surface of the head be removed and turned ventral surface uppermost [pl.43, fig.5], the two fans or rotatory organs [fig.5*f*] may be seen, mesad and caudad of which are two tufts of hair projecting caudad. Between the latter is a rounded process on which are from two to four spines. This process together with the two tufts of hair, I believe to be the epipharynx[*e*].

The eyes are large and placed laterally, behind which and lying close to, may usually be seen a small ocellus. On each side of the mouth opening, ventrad of the fans, are the mandibles; stout, quadrangular pieces with a number of sharp teeth, at the cephalic end with two stout spines curved mesad, a row of hairs arranged on a ridge or keel overhanging the teeth and another row of long hairs arranged on the posterior margin [pl.45, fig.1, 2]. A fingerlike process with hair at its apex projects mesad from the mesocaudal margin [fig. 2*a*]. Ventrad of the mandibles are the maxillae [pl.43, fig.4x]. These are also indicated by dotted lines under the mandibles [m] on right hand side, the figure being a dorsal view of the lower half of the head, the dorsal surface having been removed. The maxillae are fleshy ovoid processes with a longitudinal row or terminal tuft of hairs, besides the long, loose hairs on the mesal surface. Attached to the base and projecting laterad is the palpus with its four or five terminal spurs or papillae. Forming the floor of the mouth cavity, and attached to the anterior edge or coalescent with the sclerite which forms the lower surface of the head is the labium [pl.43, fig.4*l*]; a more or less triangular or semicircular piece with a toothed margin. The ventral surface and margin is usually fringed with setae.

The hypopharnyx is a toothed piece resembling the lower jawbone of a mammal, and lies tonguelike on the floor of the mouth cavity [pl. 43, fig.4*h* and pl.44, fig.6]. It is quite small and, being loosely attached, is easily torn away in dissection, hence somewhat difficult to find. Attached to the posterior edge of the hypopharynx [pl.44, fig.5], and lying obliquely, with reference to the frontal plane, but perpendicular to the sagittal plane, is an elliptic flat ring. This ring is compound, made up of four lamellae in close contact, so that it appears at first sight as a single ring; the surface of the lamellae is striated and fringed on the inner margin with long cilia. A portion of the front end of this ring is shown on plate 44, figure 5*s*. It appears to be the anterior margin of the gullet, and may perhaps act as a kind of sieve on which the food particles swept in by the rotatory fans, are caught. A second toothed piece [pl.44, fig.5*t*] lies dorsad of the anterior lobe of the hypopharynx, and is probably a part of it.

The thorax is circular in outline, and wider than the head. In the full grown larva the sutures separating the three thoracic segments can not be distinguished. On its surface are tufts of long bristles, longer usually than those on the rest of the body. These bristles are feathered, though not so much so as in Anopheles. The hairs appear to act as balancers. In addition to these hairs are a number of smaller, shorter tufts.

The abdomen is five or six times as long as the thorax, but of much smaller diameter; consisting of nine segments counting the anal segment. The segments are subequal in length excepting the first, eighth and ninth, which are frequently shorter. On the lateral margins are tufts of a few long hairs besides a few shorter ones, the arrangement of which may give specific characters, though, owing to the ease with which they fall off in alcoholic specimens, they must be used as distinctive characters with some caution. Projecting from the dorsal surface, near the posterior margin of the eighth segment, is a long, more or less cylindric tube, into which the two main respiratory trunks can easily be followed, and are seen to open at its extremity. On each side of this tube is a single row of short spines, and at the base is a tuft of short hairs. On each side of the eighth segment is a comb composed of a variable number of short spines [pl.45, fig.6]; the tip of each spine is sometimes covered with short hairs.

The ninth abdominal segment, usually shorter than the others and of less diameter, contains the rectum and the anus, being almost at the extremity of the body. Around the opening are two pairs of delicate, elongate lobes. These are tracheal or blood gills. Immediately cephalad of these are dense tufts of long hairs, the position and arrangement of which are variable with the species. Usually also, dorsad of the blood gills are a variable number of long bristles.

Pupa. The pupa differs from those of the other genera of this family less than does the larva. It is characterized by its bulky, oval, laterally compressed anterior part, made up of the head, thorax and its appendages, and a posterior part, consisting of the abdomen with its swimming paddles [pl.43, fig.7]. The length of pupal life in all observed specimens was about four days. During this time the pupa would remain quietly floating with its thorax nearly vertical, its abdomen bent under, unless disturbed, when it propels itself to the bottom by means of the violent contractions of the abdomen, after the fashion of a crawfish. The specific gravity apparently being less than water, however, it requires a constant effort to remain at the bottom.

The head is bent down under the thorax, the antennae folded back arcuate and lying along its sides; the legs folded up in a sinuate fashion; the wings extending downward and backward from the sides. Near the highest point of the thorax, the pupa occupying its usual vertical position [pl.43, fig.7], are the two breathing trumpets, elongate, subcylindrical tubes, open and somewhat flaring at the top [pl.44, fig.11]. On the dorsal surface near the posterior margin of the thorax, are usually a pair of stellate hairs. The abdomen has eight segments, subequal in length except the first and last two, which are shorter, and on the posterior margins of which are a few tufts of branched hairs. Attached to the last segment is a pair of broad swimming paddles, each reinforced by a stout longitudinal rib, and ending in a single short spine. Between the paddles is a furcate fleshy process in which are contained the genitalia of the inclosed imago. The shape of this fleshy process differs with the sexes, and perhaps also with the species. The pupae of all the species I have examined resemble one another so closely that I have been unable to distinguish them. It appears however that there are slight constant differences in the form of the air trumpet and in the number and arrangement of the abdominal hairs. Fresh specimens should however be examined in order to characterize them correctly.

The arrangement of the bristles on the abdomen is about the same in all the species examined. On the dorsal surface of the first abdominal segment are a pair of conspicuous stellate hairs, the remaining segments each have about three pairs of lateral discal hairs, and two pairs of small, branched, marginal ones; one of the marginal pairs of the eighth segment being many branched. Besides these there are usually a few scattered hairs.

Much has been written about the species of this genus, but the fact that most of the older descriptions are inadequate renders the synonymy much involved. Coquillett has done the best and most recent work on the North American species; and the reader is referred to his papers published by the United States Department of Agriculture, or, better still, to his table given in Howard's book on mosquitos, for the determination of the adults. In the last mentioned work will be found a most complete description of the life history of several species of mosquitos. The recent work of Theobald is a monograph of the Culicidae of the world.

Dr Dyar has recently published in the Proceedings of the Washington Entomological Society (1902 and 1903) and in the Journal of the New York Entomological Society (1902 and 1903) the descriptions of the larvae of a number of species of Culex, together with keys for their identification. The following key is adapted from one given by him, modified to include species more recently described.

KEY TO SPECIES OF CULEX LARVAE

1 Without a longitudinal row of spines on the air tube; hair tufts of anal segment confined to the barred area; seventh segment with a round dorsal plate incised anteriorly......
signifer Coq.
With a longitudinal row of spines or hair on the air tube............(2)
2 Air tube at least four times as long as its breadth at the base...(3)
Air tube less than three times as long as broad.....................(9)
3 Antennae with hair tuft beyond the middle of the joint.............(4)
The antennal tuft at or before the middle...........................(8)
4 Air tube six or more times as long as broad; antennae white banded ....(5)

Air tube 4 or 5 times as long as broad..............................(6)
5 Tube concave, the tip wider than the terminal portion. Spines of tube mostly with a single basal branch.......territans
Tube regularly tapered, smallest at the tip. Spines of the tube 3 to 4 branched..............................nigritulus
6 Anal segment without hair tufts anteriorly of the transversely barred area..(7)
Anal segment with hair tufts on the ventral line up to the base ....dyari
7 Lateral comb of the eighth segment a patch of spines; tube brown ....pipiens
Lateral comb a row of bars; air tube black............melanurus
8 Apex of the labium rounded [pl.44, fig.1]. Antennae whitish on basal half....................................restuans
Apex of labium pointed [pl.45]..........................cantans
9 Lateral comb of the eighth segment a patch of small spines three or more rows deep.......................................(10)
Lateral comb a few spines on a single or partly double row........(13)
10 Anal segment with hair tufts before the barred area...............(11)
Anal segment without tufts before the barred area................(12)
11 The spines of the air tube prolonged into setae; tube about three times as long as wide; the antennal tuft is at the middle of the joint.................................consobrinus
The air tube with spines, anal segment broadly plated..canadensis
12 Antenna with a small tuft a little before middle of the joint. Air tube about two and a half times as long as wide; lateral comb about three rows deep...............bimaculatus
Antenna with a single inconspicuous hair instead of a tuft. Air tube not over twice as long as wide; lateral comb about five rows deep...............................atropalpus
13 Anal segment with hair tufts before barred area..................(14)
Anal segment without tufts before barred area...................(16)
14 Comb of eighth segment of separate nearly simple spines, the spines of the air tube each with three teeth.......sylvestris
Comb of eighth segment either toothed or digitate.................(15)
15 Comb of eight segment composed of spines with finely digitately divided tips; antenna with a single long seta instead of a tuft..triseriatus
Comb of conspicuously toothed spines, joined on a weak basal plate. Antenna with a small hair tuft.......jamaicensis
16 Comb of eighth segment of nearly simple, thorn-shaped teeth ....sollicitans
Comb of eighth segment of pectinated spines in an incomplete double row..............................taeniorhynchus

The pupae resemble each other so closely that I have been unable as yet to find satisfactory characters to distinguish them.

Culex restuans Theobald

Plate 44

Monogr. of Culicidae, II:142

Male. Length 4.5 to 5 mm. Uniformly fuscous. Palpi as in plate 44, figure 12. The thorax is apparently marked with stripes; bases of the abdominal segments with yellow scales; bases of the femora and the tips of the tibiae yellow. Tarsal claws of the fore and middle legs unequal, each with a tooth, hind claws simple. Male genitalia resemble those shown on plate 43, figure 11; but the apex of the terminal claw is sinuous, and with a tiny hooked appendage. Wings hyaline, with fuscous scales. Venation as in figure 9. Halteres pale.

Female. Palpi as shown in figure 13. All tarsal claws simple. Venation of the wing as in figure 10. In other respects like the male.

Described from alcoholic specimens obtained from Professor Needham. Bred. Saranac Inn N. Y., July 21, 1900.

Larva. Length 7 to 8mm. The head is round, widest at the eyes, slightly wider than long, with six moderately long hair tufts in a transverse row immediately back of the antennae; the antennae slender, uniform, and brown in color but paler at the base. On the shaft is a tuft of 10 to 12 long hairs, a little below the middle, and at the tip are three slender and one stout spine and the stout apical joint. Rotatory fans normal. The mandibles have immediately above the teeth a long, stout spine with a serrated inner margin. The maxillae possess a pair of moderately long dorsal spines. The cephalic margin of the labium is arcuate, with about 23 teeth, besides three on each lateral margin [pl.44, fig.1]. The epipharynx is of the usual shape, though its lateral spines are somewhat longer than the median [fig.6]. The hypopharynx has a toothed margin and eight spines, four on each side, two lateral lobed processes each with six fingerlike projections and a median piece with a lobed margin [fig.5]. The labrum [fig.8] is hairy as usual, the clypeus [fig.8c] with two stout spines on its dorsal surface. On the gula are two trifid hairs. The thorax is rounded, and at the base of the larger tufts of hair are spurlike processes with four or five teeth projecting cephalad. The long, loosely feathered hair tufts of the thorax consist of the usual anterior transverse row, and the two lateral groups [fig.3]. The hairs of the abdomen are arranged in tufts of about equal length, though there are fewer hairs in the posterior ones; air tube brown, of moderate length, the row of lateral spines on it each with from 15 to 20 spines; caudad of which are a few long hairs. The lateral combs of the eighth abdominal segment with 30 to 32 teeth arranged in about three irregular rows. Caudad of this comb is a tuft of nine feathered hairs, and dorsad and ventrad of it are several small bristles. On the dorsal margin of the ninth segment are three or four long bristles, and on the apical third of the ventral surface is a brush of long hairs consisting of from nine to 12 tufts. In most specimens the blood or tracheal gills are long, extending beyond the tip of the breathing tube.

Pupa. The breathing trumpet [fig.11] is somewhat widened at the top, about five times as long as wide, its apical margin oblique. On the most posterior of the thoracic sclerites are three pairs of short, stout, branched hairs; on the dorsal surface of the first abdominal segment, are the usual pair of stellate hairs; the remaining segments each have about three pairs of lateral discal hairs and two pairs of small branched marginal ones, one of the marginal pairs on the eighth segment being many branched.

Culex pipiens Linnaeus

Plate 43

Male. Length 4mm. Antennal joints grayish white, the tips black, the long hairs brown; proboscis and palpi pale fuscous, the latter darker at the tip with long, dark brown hairs; occiput with yellowish hairs; dorsum of thorax yellowish brown, with five indistinct, darker brown stripes, on each of which is a row of a few black or brown bristles, elsewhere covered with yellow scales; pleura metanotum and scutellum yellowish brown, the last slightly darker, with a few long brownish hairs; abdomen long haired, segments fuscous, at the base rather widely fasciated with yellow scales; ventral surface paler fuscous; genitalia yellowish, not very prominent [fig.11]; legs fuscous, quite pale on the coxae and base of femora, gradually becoming darker distally, the tarsi being quite dark; the knees and extreme tip of tibiae, yellowish. The fore and middle pairs of claws unequal, the longer one inside, each claw with a distinct tooth [fig.8]. The hind claws simple. Wings hyaline, scales fuscous [fig.10]. Halteres pale.

Female. Length 4mm. Antennae, proboscis and palpi uniformly fuscous; abdomen fuscous, with a very narrow basal fascia of yellow scales on each segment; ventral surface paler; femora with basal half and flexor surface yellow, gradually becoming darker distally, tibiae and tarsi as with the male. All tarsal claws simple [fig.9]. Wings with fuscous scales. Venation as in figure 12. All else as with the male. Bred specimens. July 18, Aug. 31, and Sep. 7, 1901. Ithaca N. Y.

Larva. Length 7 to 8 mm. The head is nearly circular in outline, color pale fuscous, with six moderately long tufts of hair on the dorsal surface, the lateral ones near the base of the antennae, the others more caudad [fig.2]; eyes large; antennae flattened, wider on the portion below the hair tuft, which is composed of 20 to 30 loosely feathered, long hairs on the side at about two thirds its length from the base; its apex with four slender and one stout bristle besides the short apical joint. The rotatory fan [fig.5*f*], labrum [*lr*] and epipharynx [*e*] normal; clypeus with the usual pair of setae; the mandibles with a long, stout, curved, pale brown spine with a serrate inner margin, projecting beyond the black teeth. A pair of small spines are found on the dorsal surface of the maxillae, and a small seta near the apex [fig.4*x*]. The cephalic margin of the labium [fig.4*l*] is elliptic, the median tooth longer than the others, and the hypopharynx [*h*] is of the usual shape [pl.44, fig.5]. The thorax is rounded; arranged on the dorsal surface in a transverse row near the cephalic margin are 10 or 12 equally spaced tufts of long hairs, the median tuft largest. A little caudad of the middle line, near the lateral margin are six or eight long hairs in an irregular transverse row, and on the lateral posterior margin, are two tufts of five or six short hairs each. The outline of the abdomen presents a sinuous margin, the segments being somewhat constricted at the incisures. On the prominence of each side of the segments are three or four moderately long hairs. The lateral combs of the eighth segment consist of a patch of about 50 spines. Caudad of the lateral comb is a tuft of about eight feathered hairs, and dorsad and ventrad of this is another smaller tuft. The ninth segment has five or six long setae on the dorsocaudal margin, 13 or 14 branched hairs of about six branches each on the caudal third of the ventral surface and four rather long sharply pointed blood or tracheal gills. The breathing tube is rather long, with from 10 to 15 serrate spines in a longitudinal row on each side, and on the ventral surface are three pairs of long and several short tufts of hair.

Pupa [fig.6, 7]. The breathing trumpet is comparatively long, widest at the apical third, its opening extending downward on one side to almost the middle. On the abdomen are the usual bristles, those on the lateral margin being larger toward the caudal end. Swimming paddles are of the usual shape.

Culex cantans Meigen

Plate 45

Syst. Beschr. 1818. 1:6, 2:6

1848 C. stimulans Walker. List etc. Synonymy according to Coquillett.

Male. Length 7 or 8 mm. Antennae with long fuscous hair; proboscis and palpi yellowish brown, the latter with a band of dark scales near the base; joints dark; occiput with yellowish white scales; thorax with a black or brown ground, thickly covered with short golden yellow hairs, with five narrow longitudinal stripes of white scales. The lateral stripes are not parallel with the intermediate pair, but, starting anteriorly quite close together, diverge rapidly and end near the base of the wing. The white stripes are frequently quite indistinct, in which case the thorax might be described as having two rather wide yellowish stripes; pleura and scutellum with whitish hairs; metanotum brown and bare; each segment of the abdomen dorsally with its anterior third covered with short, whitish scales, which extend also in a narrow more or less broken line along the lateral margin. Posterior part of the segments is black with an occasional paler scale, particularly on the posterior margin. The last segment is nearly covered with white scales. Venter with yellowish white scales, which are rather thickly interspersed with long, pale brownish hairs; hypopygium prominent, black; flexor surface of the femora white, extensor surface sprinkled with brown; flexor surface of the tibiae and metatarsi yellow, extensor surface brown; tarsi black with the basal third or fourth white. Claws all with a tooth on the underside of each. One claw of the middle foot is much longer than the other and is sinuous in outline [fig.10]. Wings hyaline with blackish scales and a sprinkling of paler ones. Fourth tarsal joint of the male short. Venation as in figure 9. Halteres white.

Female. Antennae pale brown; proboscis fuscous; venter of abdomen without long hairs; genitalia black; anterior femora and tibiae brownish, with scattered whitish hairs; fore and middle tarsal claws with a single tooth, hind pair simple. In all other respects like the male.

Larva. Length 11 to 12 mm to the tip of the breathing tube. The head is dark brown, antennae with two slender and two stout apical setae and a short terminal joint; at a little below the middle is a tuft of about eight hairs, and on the shaft are a number of short, thick spines. The color of the antennae is a uniform dark brown. The rotatory fans are rather long, the individual hairs are noticeably pectinate at the tip. The mandibles, maxillae and labrum are normal, the latter apparently without the pair of dorsal spines, possessing a long, thick tuft of hair apically and a comparatively large palpus. At the base of the palpus on the triangular sclerite is a stout spine, and caudad and mesad of this is another, placed close to the suture which separates the lateral from the ventral sclerites of the head. The labium resembles that of C. triseriatus but is somewhat more rounded, the middle tooth prominent. The thorax is transversely oval, with three or four rather short, stout setae on the cephalolateral margins, caudad of which and near the lateral margin is a tuft of short hairs; on the middle of the lateral margins are two tufts of feathered hairs, and caudad of this is another pair. The abdominal segments are slightly constricted at the incisures; the first segment has three or four long feathered hairs on each side; the rest of the segments each have about two on each side, besides some short, scattered ones. The lateral combs of the eighth segment have 35 or 40 teeth each. The ninth segment has a tuft of about 16 dorsocaudal bristles, one of them longer than the rest, and on its ventral surface are about 16 tufts, the first four somewhat separated from the rest and from each other. The dorsal surface of the segment is covered by a brown chitinized saddle. The tracheal or blood gills are of moderate length. The breathing tube is long, about four or five times as long as wide; with 20 or 25 lateral serrate spines in the longitudinal row, the basal four or five being smaller than the rest.

Pupa. The pupa greatly resembles those of the other species. The breathing trumpet widens at about one third the distance from the base, its open end only slightly oblique.

Described from a number of bred specimens. May 1901. Ithaca N. Y.

Culex sylvestris Theobald

Monogr. Culicidae. 1:406

This species will fall in the same couplet with C. stimulans Walker (=C. cantans Meigen), in the key given in Dr Howard's book on mosquitos (1901 ed.). It is apparently not uncommon and has probably heretofore been confused with the above mentioned species. It greatly resembles C. cantans, it also agrees fairly well with the descriptions of C. vexans Meigen and with Walker's description of C. stimulans. From the first it differs in having (in *unrubbed*, bred specimens) an unmarked thorax, and in having only the immediate bases of the tarsal joints white. The male also has the long claw of the middle foot slightly curved but not sinuous [*compare* pl.45, fig.10 and pl.40, fig.11]. From C. stimulans it differs in having the posterior fork cell wider and shorter than the anterior, while in stimulans, according to Giles, they are "of about equal length and breadth." From both of the foregoing and from C. vexans also, the male differs in having a white band on the middle of the long second joint of the palpus. In spite of the tooth on the underside of the hind claws I believe my identification is correct.

Male. Length 5mm. Antennae with long fulvous hairs, proboscis and palpi dark brown, the latter with a white band on the middle of the long second joint, and the bases of the third and fourth joints white. The occiput with golden yellow hairs and patches of blackish and whitish scales; dorsum of the thorax with a black or brown ground uniformly covered with golden yellow hairs, the posterior margin and the scutellum with a fringe of longer yellow hairs; metanotum light grayish brown, bare; pleura brown with whitish scales.

Each segment of the abdomen dorsally with its anterior fourth covered with short white scales; posterior part of the segments black slightly produced forward in the center and the posterior margins of the next to the last whitish; the last one wholly black; genitalia brown, the apical joint slender with a spine near its apex [pl.40, fig.12]; venter pale brown with whitish scales; entire abdomen with long, erect pale brown hairs; femora brownish, the bases and the flexor surface of the middle and hind pairs and sometimes the front pair also, white; tibiae and tarsi brownish black, flexor surface paler; the immediate base (about one eighth of the length) of each joint of the tarsi yellowish white. The hind legs with erect, yellow setae. All tarsal claws with a tooth on the under side of each. The long claw of the middle foot as shown in figure 12. The venation is about as that shown for C. cantans, though the posterior cross vein is not oblique. Halteres yellowish white.

Female. Differs from the male only as follows. Antennae brown, basal two or three joints yellow; abdomen marked like the male, but the long hairs are only on the posterior margin of each segment; genitalia black, consisting of two fingerlike lobes; venter yellow with white scales, posterior margin of the segments black. Tarsal claws like the male.

Described from bred specimens.

Larva. The larva resembles that of C. cantans. The mandibles are like those shown on plate 45, though the teeth are more blunt; the maxilla is like that shown on the same plate, though the palpus is rather shorter than shown here, and there are two lateral spines. The labium is pointed, and the antenna has a tuft of bristles near the middle. The teeth on the sides of the eighth segment are arranged in one irregular row. The spines of the longitudinal row of the breathing tube each have two or three short teeth near the base, the two or three elongate distal spines being separate from the others and from each other. Breathing tube about two and one half times longer than wide. The setae of the ninth segment extend forward from the barred area.

Pupa. The plane of the margin of the breathing trumpet makes about a 30° angle with its long axis. Specimens taken July 10, 1902, Ithaca N. Y.

Culex triseriatus Say

Plate 46

Acad. Sci. Phila. Jour. 3:12. 4 Compl. Wr. 2:40; Wiedemann, 1:11, 12

Female. Length $4\frac{1}{2}$mm. Antennae uniformly grayish, the large basal joint yellowish, the joints of the flagellum verticillate, with a few long, black hairs, besides which the shaft is covered with sparse grayish white, downy hair; proboscis fuscous, including its base and the epistome. Palpi one fourth as long as proboscis, cylindric. Occiput covered with silvery white scales; dorsum of thorax with a very broad black stripe, widened posteriorly, where it covers the space to the base of the wing excepting a spot of white scales in the middle line on a line with the bases of the wing; scutellum and metanotum black; the sides of the anterior part of the dorsum, and the pleura, covered with white scales; abdomen covered with deep black scales. The anterior margin of the dorsal surface of the segments are fasciate with dark brown scales, and the anterior margin of all segments on the ventral surface fasciate with white scales. These latter fasciae extend to the sides and their extremities are just visible on the dorsal aspect. The last segment is yellow, genitalia black; the legs black, the coxae, the flexor surface of all the femora, the bases of the first and second pairs, the basal two thirds of the hind pair, and all the knees, white; tarsi sometimes dark brown. The fore and middle pair of tarsal claws each with a tooth, those of the hind pair simple. Wings smoky, the scales black, those on the posterior margin brown. Venation as in figure 7. Halteres white.

Male. Antennae wanting. Like the female in all respects excepting as follows. The black dorsal stripe slightly narrower; the long palpi are black, hypopygium prominent, the front tarsal claws of unequal size, one long and curved, the other shorter and nearly straight; both with a single tooth on the underside, the middle claws each with a tooth, hind ones simple. Described from specimens bred July 1901. Ithaca N. Y.

Larva. Length 7 to 8 mm. Head [fig.3] is round, in color brown; in the transverse row between the bases of the antennae are six tufts of hairs, the median pair short; caudad of these is one pair of long setae, and directly caudad of each eye is a single one. The antennae [fig.1] have three or four apical bristles besides the usual small terminal joint, and a little distad of the middle is a single long seta. Labrum, rotatory fan and maxillae normal, the two dorsal spines of the latter rather longer than in C. pipiens and the papillae on the mesal surface are more prominent. The spines of the epipharynx as in C. pipiens, but the lateral ones shorter than the median pair. The stout apical spine of the mandible [fig.2] does not project beyond the tip of the teeth. The labium [fig.4], is triangular with 19 teeth, hair on its ventral surface, and caudad of the transverse suture are two pairs of setae. The hypopharynx, shown somewhat diagrammatically in figure 6, has a number of sharp teeth besides two lateral lobes with fingerlike processes (not shown in the figure). On the dorsal surface, along the cephalic margin of the thorax, are six or eight hair tufts, all rather short except the lateral ones, which are of moderate length; on the middle and on the posterior end of the lateral margin are two long tufts. Near the caudal margin are two stellate hairs. Each abdominal segment has, besides the long lateral tuft, four short dorsal tufts and a few short lateral and ventral hairs. The lateral comb of the eighth segment is composed of about eight spines arranged in one irregular row; the ninth segment but little longer than wide, is provided with a dorsocaudal tuft of 10 or 12 hairs, a ventral row of about 10 tufts, each tuft with four or five hairs. The blood or tracheal gills are comparatively short. The breathing tube is short, about twice as long as wide, with a lateral longitudinal row of 18 to 20 spines, at the caudal end of which is a single hair tuft.

Pupa. The pupa does not appear to differ from C. cantans. The air trumpet is widened at the top, the plane of the margin of the aperture makes about 45° with the longitudinal axis. Bred specimens. July 1901. Ithaca N. Y.

Genus AEDES Meigen

Small, brownish or blackish gray species closely resembling Culex, differing only in that both sexes have very short palpi. According to Van der Wulp, the palpi, though short as in the female of Culex, are not cylindric as in the latter genus, but conical or pointed, and consist of two joints only. But two species of adults are known from the United States.

A. fuscus O. S., Western Diptera. 1877. p.191. Cambridge Mass.
A. smithii Coquillett, Canadian Ent. 1901. p.260. New Jersey.

Imagines

These two species may be distinguished as follows:

With cross bands of yellowish scales at the bases of the abdominal segments	A. fuscus O. S.
Without these bands	A. smithii Coquillett

Larvae

With four anal blood gills	fuscus
With two anal blood gills	smithii

Aedes fuscus Osten Sacken

The larva is described by Dr Dyar in the Journal of the New York Entomological Society for 1902, page 197. This larva differs from that of A. smithii in having four long narrowly taper-pointed blood gills instead of but two. The antenna has a tuft of hair a little before the middle; the breathing tube is about three times as long as wide; its spines are single toothed. The ninth segment has tufts before the barred area; the lateral combs of the eighth segment consist of a single irregular row of rather course spines.

"The pupa is normal, its air tube cylindrical, slightly bent but not widened into funnel shape."

Aedes smithii Coquillett

Plate 47, fig. 1-6

The adult is described by Coquillett in the *Canadian Entomologist*, 1901. Of the life history Prof. J. B. Smith has discovered the following:[1]

"The female Aedes lay their eggs in the newest leaves of the pitcher plants (Sarracenia), and do not always wait for water to collect in them. Of the specimens of larvae which he had taken during the winter the last one changed to the pupal state about Sep. 9; thus being in a larval state since the preceding October. He thought that there were about three broods, and that the different specimens vary in their time of appearing, which seems to give one continuous season."

The larva has already been well described by Dr Dyar, in New York Entomological Society Journal, December 1901, page 178, plate 10, figure 1. It greatly resembles the larva of Culex, this species differing from the known members of that genus in the following particulars. The mandible has but one large bristle or curved spine at the apex (in all specimens examined); the papillae of the maxillae are elongate and sharply pointed; and the blood gills at the posterior end are only two in number.

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[1] Ent. News. 1901. p.254. *See also* N. Y. Ent. Soc. Jour. March 1902.

The characters of the species are as follows: Head rounded, somewhat flattened; eyes very small, round, and black; rotatory fan conspicuous; antennae slender, uniformly pale in color, the lateral tuft represented by a single seta, its terminal appendages short, consisting of two or three slender setae, a blunt spine and the usual short terminal joint [pl.47, fig.1]. The mandibles [fig.2*m*] are shaped like those of Culex but appear to have but one stout, curved seta at the apex; the bearded process caudad of the teeth has a stouter base than in Culex; maxillae [fig.2*x*] elongate, pointed papillae and several terminal setae besides the usual long hairs. The labrum resembles that of Culex, the clypeus with a pair of rather elongate blunt spines. Epipharynx as in Culex, though with but two instead of four spines. The labium triangular with a long central tooth and nine teeth on each side of this [fig.2*l*]. The gula is apparently without setae. On the dorsal surface of the head between the bases of the antennae in a transverse row are four small setae, and caudad of each of the two inner ones is another. Thorax quadrate, wider than long, lateral margin sinuous; dorsal hairs short, those of the three lateral groups long; abdomen slender, segments subequal in length, the long lateral hairs about of equal length, those on the anterior segment, four to six in number, diminishing in number caudad, so that on the last two segments there are usually but two on each side. The dorsocaudal and ventrocaudal tufts short and composed of two or three hairs. The lateral combs of the eighth segment consist of 15 to 20 stout teeth arranged in a single somewhat irregular transverse row. The air tubes rather short, about three times as long as its greatest diameter; with four rows, each with five or six long setae [fig.6]. The two longitudinal rows of teeth which are present in Culex are entirely wanting. The anal segment is short, with two inflated translucent blood gills and with dorsocaudal, laterocaudal and ventrocaudal tufts of long hairs; the ventral brush wanting.

The pupa has the posterior margin of the swimming paddles ciliate with short hairs instead of terminating with a single bristle as it does in Culex. Near the anterior margin of the thorax is a pair of long setae, caudad of which are two pairs of short forked hairs. The breathing trumpet [fig.4] is like

Culex, the plane of the margin being about at right angles with the long axis of the tube. On the dorsum of thorax is a pair of short forked hairs just caudad of the trumpet; on the metathorax is a transverse row of slender setae, and caudad of the base of the posterior margin of the wing are five or six rather long setae. The two stellate hairs on the first abdominal segment are very conspicuous. The rest of the segments each with a few subdorsal hairs; on the posterior end of the lateral margin of segments 4, 5 and 6 is a single long one, and on 7 and 8 a conspicuous fan of hairs [fig.5]. The swimming paddles are rather small and with cilia on posterior margin. The thorax in mature specimens is dark brown, the abdomen paler.

Described from specimens kindly furnished by Prof. John B. Smith.

Genus URANOTAENIA Arribalzaga

This genus possesses in most respects the same characteristics as Culex and Aedes; it differs from Culex however in having short palpi in both sexes, agreeing in this with Aedes, but differs from the latter in having violet blue scales on the thorax. The palpi of both sexes are two jointed, the basal joint globular, nearly as large as the basal joint of the antennae, the apical joint small, conical and pointed; differing thus from the cylindric palpi of the female Culex.

Uranotaenia sapphirina Osten Sacken (Aedes)

Plate 46, fig. 8-15

Am. Ent. Soc. Trans. 2:47

"Wings unspotted; abdomen dorsally brownish, thorax tawny brown with a median dorsal, and three lines on the pleurae, metallic blue; tarsi brownish, unbanded." Description of Osten Sacken. 1868. 2:47. "Fuscous, the frons, a median thoracic line and stripes on pleurae metallic blue; bases of coxae and femora pale; apexes of the femora and tibiae snowy. Front blackish, with a metallic blue reflection along the eyes, specially in the middle. Antennae blackish, scapus tawny; those of the male apparently 15 jointed (13 plus two), flagellum with 12 beautifully bearded joints; a 13th elongated, linear joint has some scattered hairs, but no beard like the preceding ones. Proboscis long, reaching in the male if bent backward, to about the middle of the abdomen; rather conspicuously incrassated at the tip; perhaps still longer in the female (abdomen of my female injured); thorax brownish, tawny, darker above, paler on the pleurae; a metallic blue longitudinal line along the middle of the thorax reaches the scutellum; three similar marks on the pleurae, the upper of which is in the shape of a short line running from base of wing toward the head. Abdomen brownish above, paler below; knob of halteres brown, stem pale. Feet brownish paler at the base; a snow-white dot on the upper side of tip of femora and of tibiae; when looked at very obliquely, these white dots appear slightly pale bluish, and the tibiae and tarsi likewise show a faint bluish reflection. Wings clothed with brown scales, but showing in an oblique light numerous blue reflections, especially a stripe near the basis between the third and fourth longitudinal veins. Obs.—In female specimen the scales are rubbed on the feet; therefore appear pale tawny; still, white dots are distinctly visible. Length 3mm. Wing 3mm. Habitat United States, Washington D. C., Brooklyn N. Y."

To the above I may add that in well preserved specimens the abdomen has a very narrow, pale posterior margin, and that the female also possesses the white spot at the tip of the femora, rather faint, and at tip of tibia very distinct. The tarsal claws of both male and female are simple, the middle tarsi of the male with but a single large strongly curved claw [fig.15]. The claws of the hind legs small and but slightly curved. Wing venation as in the figures [fig.13 female, fig.14 male]. The hypopygium of the male, moderate sized with the jointed appendage slender and curved up at the tip [fig.12]; its ventral tooth simple.

[Pl.46, fig.8-15]. The larva and pupa, and the life history of this species are described by Dr Dyar.[1] According to the figures and description given by Dr Dyar, this species differs from the known members of the genus Culex in the following particulars: "Antennae moderate, divergent [fig.10]. The hairs of the thorax and abdomen [fig.8] black, the thoracic ones equal, long; those of the first and second abdominal segment also long; but the rest very short and inconspicuous, stellate. The lateral comb [fig.9] of the eighth abdominal segment is a large plate with a row of stout teeth on the posterior edge . . . air tube rather short, not longer than two segments, widened at the tip by four distinct, flattened teeth, as long as the width of the tube; last segment moderate, with the usual four anal fingers (blood gills). Pupa essentially as in Culex. . . Segments dorsally tufted with stellate hairs and some small tufts about the eyes and between the prothoracic air tubes. Tubes long, slender, uniform in width, not flared, but slightly bent in the middle, about 12 times as long as wide."

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[1] N. Y. Ent. Soc. Jour. 1901. 9:179.

Family DIXIDAE

Dixa midges

Plate 48

These little flies closely resemble mosquitos in size and form; but may easily be distinguished from them by the venation of their wings, and in that the veins are not furnished with scales [pl.48, fig.8]. The antennae are about 15 jointed, and differ but slightly in the two sexes; the legs are long and slender; and the caudal end of the abdomen of the male is enlarged. The family includes only a single genus, Dixa. The flies appear to be rare in America; at any rate are rarely observed.

The larvae of several European species are known. The following is the first published description of the larva of an American species, as far as I am aware.

Dixa modesta nov. sp.

Mr Henshaw kindly compared this species with Loew's types in the Cambridge Museum and he found that it differs from all of them.

Male and female. Brown, dorsum of the thorax between the dark stripes yellowish; scutellum, middle and hind coxae, and tip of the abdomen either yellowish or pale brown. Length 2 to 2.5 mm.

Head dark brown, including palpi, antennae, and proboscis. Thorax including the pleura, metanotum, and sternum, brown; dorsum yellow with three wide brown stripes, scutellum yellowish or pale brown. Abdomen dark brown or black, venter a little paler, last segment yellowish, tip of genitalia black. Legs brown, middle and hind coxae yellowish, and the basal portion of the femora more or less yellowish brown, the tarsi and the tips of the tibiae almost black. Wings hyaline very faintly cinereous, veins fuscous, cross vein not clouded; the peduncle of the Cubitus about as long or but little longer than the fork. Venation as shown in figure 10.

Described from a number of captured and bred specimens. April and October 1902. Ithaca N. Y.

Larva. The larva is found in pond water or in slow flowing streams. It is almost always bent double in the shape of a letter U [fig.5], so that the head and tail come close together; the bend being at the sixth segment. When kept in a tumbler of water, it will lie on the side of the glass with its body above the water level; its head and tail toward the water. It appears however that it is still within the surface film. Its general color is a pale fuscous with black head and appendages. The body consists of three thoracic and eight abdominal plus the anal segment. The head [fig.1] is somewhat quadrangular in shape, with the antennae at the anterior lateral margins. On the dorsal head sclerite are three pairs of setae arranged as in figure 6; and on the ventral surface are also three pairs besides a smaller one at the base of each antenna, as shown in figure 1. The antennae are slender, slightly curved, and deep brown in color, with numerous sharp, distad projecting tubercles or spines. The labrum is attached to the cephalic margin of the dorsal sclerite [fig.6] and hangs flaplike over the mouth. The margin is heavily fringed with dense tufts of hair which appear to act as rotatory organs. Ventrad of this are the mandibles [fig.2], short and stout, each with a curved spine at its cephalic end, a pair of curved setae on its outer (lateral) margin, and a row of fine, curved hairs overhanging the two short, sharp teeth in its inner (mesal) margin. The maxillae are ventrad of the mandibles, and are well developed. At the apical end of each are a few fine, curved hairs [fig.3], and on its outer surface are short, scattered hairs. Its palpus [fig.3*p*] greatly resembles the antenna, but is a little smaller. On its basal joint is a stout seta. The labium is semicircular in outline, with hairs on its apical margin, but apparently without teeth.

On the dorsal surface of the first thoracic segment are a few long, cephalad projecting setae, and a few shorter ones on each of the following thoracic and abdominal segments. The first two abdominal segments each have anteriorly on the ventral surface a pair of short prolegs with rows of short, curved bristles [fig.5*c*]. The ventral posterior margin of each of the eighth, ninth, and tenth body segments (fifth, sixth and seventh abdominal segments) is a fringe of stout caudad projecting bristles [fig.5*b*].

The appendages of the last segment of the abdomen superficially resemble those of Anopheles. The spiracles open on the dorsal surface [fig.7*s*], and surrounding each of these and extending laterad is a leaflike plate with a ciliated margin. Immediately cephalad of these is a transverse row of six short branched hairs. Extending caudad are two long, dark brown fingerlike lobes, each with a marginal fringe composed of a single row of stout setae; and lying between these is a third, cylindric, nearly black in color, provided apically with three pairs of long black setae, and a short, pale yellow terminal joint [fig.7]. The middle lobe does not extend quite so far caudad as do the lateral lobes, differing in this respect from the described (European) species. It is a little more than twice as long as wide. Of the four small respiratory gills figured by Meinert in *De eucephale Myggelarver* nothing is to be seen in the specimen from which the drawing was made, though they are present in specimens discovered later. Caudad of the spiracles and lying on the dorsal surface is a triangular chitinized plate, the rounded vertex pointing cephalad, the basal angles each provided with a single short seta [fig.7*p*]. On the ventral surface, at the base of each of the long lateral lobes, is a short, semicircular lobe with a marginal row of short, black spines [fig.5*a*]. On each side of the middle line and caudad of the small lobes is a black ridge or keel with two black setae, the longer one projecting caudad, the shorter one projecting laterad; and extending transversely between the bases of these setae is a matted fringe of fine, pale yellow caudad projecting hairs.

Pupa. The pupa [fig. 4] is pale fuscous. The single observed specimen assumed a nearly circular position, its caudal end nearly touching its head, and remaining motionless on the side of the glass above the water film. Normally a Dixa pupa rests on its side, and according to Meinert it may thrive either in or out of water. The length of pupal life is about three days. No setae were observed on any portion of its body. The breathing trumpets are short, with widely flaring conical mouths. There are eight abdominal segments besides the anal one. The anal segment has two long, pointed lobes with very finely serrate margin and a few short, terminal hairs.

The larva on which this description is based, was found in Ithaca N. Y. in a slow flowing stream Ap. 11, 1902; it pupated Ap. 18, and emerged three days later. A number of specimens were found in October.

KEY TO SPECIES OF DIXA

In order to facilitate identification, the following key is offered, which must however be used with caution, as it is in part compiled from descriptions.

1 Species having both the proboscis and the scutellum yellow..........(2)
Having either proboscis or scutellum black..........................(4)

2 Knob of the halteres black. With the head, palpi, base of the antennae, thorax, venter and the legs except the tip of the femora, yellow. Length 2.7mm. Berl. Ent. Zeit. 1863. Centur. 3, p.1. District of Columbia............marginata Loew

Knob of the halteres yellow. With the head, antennae, palpi (except the base), thoracic stripes and part of the legs brown or black...(3)

3 Cross vein with cloud. "The peduncle of veins R_1 and R_2 very short." Female. Length 2.7mm. Berl. Ent. Zeit. 1863. Centur. 3, p.4. Maryland and New Jersey (Johnson) ....notata Loew

Cross vein not clouded. Peduncle of this vein as usual; a little shorter in the male than in female. Length 2.5mm. Berl. Ent. Zeit. 1863. Centur. 3, p.3. New York and Ithaca N. Y. (=? D. recens Walker)...............terna Loew

4 Species having both the proboscis and the knob of the halteres black ....(5)

Having proboscis and halteres of different colors...................(6)

5 Thorax with yellow space between the dark dorsal stripes. Ithaca N. Y...................................modesta n. sp.

Without yellow on dorsum. Blackish species. Lower part of the pleura, sometimes scutellum and metanotum, coxae and base of the femora, and stem of the halteres yellow. Male and female. Length 2.5 mm. Berl. Ent. Zeit. 1863. Centur. 3, p.5. New York................................fusca Loew

6 With yellow rostrum; halteres with a fuscous head. Head, palpi, antennae, thoracic and pleural stripe, abdomen and tip of femora wholly black; tarsi fuscous. Length 3 mm. Male. Berl. Ent. Zeit. 1872. Centur. 10, p.1. Texas.venosa Loew

With black proboscis; halteres yellowish; palpi and proboscis and tips of femora and tibia black...............................(7)

7 Antennae and scutellum black; pleura and metanotum black; and tarsi and abdomen fuscous black; halteres sordidly yellow. Male 2.7 mm. Berl. Ent. Ziet. 1863. Centur. 3, p.3. New York, (=D. nova Walker?)........centralis Loew

Antennae yellow at the base, flagellum pale fuscous, scutellum fuscous testaceous; tip of posterior tibiae thickened. Metanotum black with yellow margin; abdomen shining cinereous black; tarsi black toward the tip. Male and female. Length 4.2 mm. Berl. Ent. Zeit. 1869. Centur. 8, p.1. Massachusetts ....clavata Loew

Family CHIRONOMIDAE

This family is exceedingly rich in species. Owing to the fact that the life history of comparatively few is known, it is difficult to give a key even to the genera of the larvae and pupae. The Chironomidae may be divided into three groups, the first containing Chironomus and allied genera, the second containing Tanypus and some others, and the third, Ceratopogon etc. Besides this, there are a few aberrant genera which can not well be placed in any of the above mentioned groups.

The bibliography of the biologic literature is rather extensive, specially for European species; and I will therefore give only that which may be of particular interest to the American reader.

Brauer, F. Syst. Studien auf Grundlage der Dipteren-Larven nebst einer Zusammenstellung von Beispielen aus der Literatur ueber dieselben und Beschreibungen neuer Formen. Denkschr. d. k. zoo. bot. Gesell. Wien. 1883. 47:1-100, pl.1-5

Fries. Monographia Tanyporum Sueciae. 1824

Gercke. Verh. Ver. Hamburg. 1877. 4:6, and 1880. v. 6

Kieffer, J. J. Allgemeine Zeitsch. f. Ent. Aug. 1901. Ceratopogon and Wulpiella

Meinert, Fr. De eucephale Muggelarver. With extensive bibliography. 1886

Miall & Hammond. The Harlequin Fly. On the Life History and Anatomy of Chironomus dorsalis. With bibliography. 1901

Packard, A. S. On Insects Inhabiting Salt Water. Am. Jour. Sci. no. 2. 1871. Species of Ceratopogon (nec Tanypus)

—— Essex Inst. Proc. 6:42. Chironomus oceanicus

Pettit, R. H. Mich. Acad. Sci. 1900. p.110. A Leaf-mining Chironomus

Osborn, H. Iowa Exp. Sta. Bul. 32. Chironomus Larva

Smith, Sidney. United States Fish. Com. v.2, Rep't for 1872 and 1873. Sketch of the Invertebrate Fauna of Lake Superior. Larva of Chironomus

The Chironomidae are gnatlike flies of slender form, the males conspicuous for their plumose antennae. They may be distinguished from mosquitos, which they resemble very much, by the costal vein not being continuous on the posterior side of the wing. The larvae are soft skinned, wormlike, and usually aquatic, though some are terrestrial. These midges are often seen, specially in the early spring or in the autumn, in immense swarms, dancing in the air. For a more complete characterization of the family the reader is referred to Comstock's *Manual for the Study of Insects* or to Williston's *Manual of the North American Diptera*.

Gercke, in *Verh. Ver. Hamburg*, 1878, 4:225, distinguishes the larvae of Chironomus and Tanypus thus: "All Chironomus larvae have a cylindrical body, a short oval head; the smaller species yellowish in color, often colorless; the larger ones often a deep red. All Chironomus larvae build a cylindrical, gelatinous, or silky case, in which they usually are hidden. The larvae of Tanypus possess a distinctly segmented, somewhat flattened body, with long conical anal prolegs, an elongate triangular head, with distinct eye spots. They do not appear to build a larval case." Those Ceratopogon which in the adult state do not possess hairy wings, have aquatic larvae. These are very elongate, snakelike in form, with a conical head, no thoracic or caudal appendages, save sometimes a few bristles at the tip of the last segment.

The pupa of Chironomus usually lies hidden in the larval case, keeping the water surrounding it in circulation by the undulating motion of the abdomen. The pupa of Tanypus is active and resembles that of Culex. The pupa of Ceratopogon is more elongate than that of Tanypus, and is not active, but floats nearly motionless, with its body in a vertical position.

For determining the genera of the imagos, the table given by Williston in his *Manual of the North American Diptera* is most useful.

Chironomus (sens. str.) sp.

Plate 49

A large number of larvae and pupae were taken from the stomachs of brook trout, as has been described by Professor Needham in this bulletin. Many specimens were examined and all found to belong to the same species. The species evidently being of great importance as fish food, it is desirable that it may in the future be recognized, and therefore I herewith describe it. Many characters here given apply to the genus as well.

Body slender, 12 segmented, full grown specimens about 18mm in length. Occasionally, still living specimens were found within the fish stomachs; these possessed the brilliant red color so characteristic of certain Chironomid larvae. At the anterior end of the first segment and at the posterior end of the 12th are pairs of prolegs. The head is small, dark brown, heavily chitinized, a little longer than wide. The sclerites of the head consist of a dorsal, ventral and two lateral plates, besides a number of smaller ones. The dorsal sclerite resembles that shown on plate 50, figure 4; but there are three pairs of bristles near the suture on the dorsal plate, the anterior pair quite close to the anterior margin [pl. 49, fig.8], and laterad of the posterior pair, lying close to the suture, but on the lateral plate is another seta. The median plate carries the labrum [*lr*, fig.8], which hangs flaplike in front of the mouth and may be bent backward, and on its under surface are three pairs of setae. Attached to the labrum on its ventral surface is the epipharynx [fig.3*e*]. This is a complex structure attached at its anterior margin, its free margin projecting ventrad and caudad. On its surface are a number of spines, its margin is serrate and provided with three pairs of small serrate teeth. In addition to this is a pair of long, chitinized, sickle-shaped processes. The shape and the arrangement of the setae are as shown in figure 3. The lateral plates bear two pairs of rudimentary eyes (pigment spots), as well as the antennae and the jaws. The antennae [fig.2] are situated on the anterior end of the lateral plates; they are small, consisting of a comparatively long basal joint, on which are two terminal pieces, one four jointed, the other somewhat shorter and simple. The mandibles, situated ventrad of the antennae are stout and with a four or five toothed apical margin. Near the base, overhanging the teeth, is a brush of hair [fig.6 and fig.8*m*]. The mandibles are articulated in such a manner that they move in an oblique plane, striking the labium [fig.8*l* and fig.5*l*]. The labium is attached, or rather coalescent with the front margin of the ventral sclerite of the head, the suture separating this sclerite from the lateral ones only faintly marked. Miall & Hammond consider the ventral piece as a portion of the lateral sclerite. The margin of the labium is toothed, the three middle teeth somewhat shorter than those immediately laterad of them [fig.5*l*]. Near the base and ventrad of the mandibles are the maxillae, consisting of fleshy processes, with forward projecting teeth on the lateral margin; a bunch of slender lobes and setae on the inner margin; and a short stout palpus with some terminal spines and papiliae [fig.5*mx* and fig.9]. On the ventral surface is a long stout seta. On each side of the labium is a striated and flexible fan-shaped flap which helps to close in the mouth [fig.5]. On the floor of the mouth cavity, lying close to the labium, is the hypopharynx. Its anterior margin is furnished with a number of short spines and bulb and platelike projections. This is the piece which Miall & Hammond, in their work on *The Harlequin Fly*, on page 29, call the upper plate of the labium, or mentum in the figure on page 30. Its function seems to be that of a guide for the silk thread, as is undoubtedly the case with Simulium. The prothoracic pair of feet [fig.4] are furnished with a large number of slender curved hairs, yellowish in color, the two feet very close together so that they appear as one. The first three segments in specimens which are ready to transform are enlarged and represent the thorax; the intermediate segments are subequal in length and apparently without trace of setae. On the ventral surface of the 11th are two pairs of long blood gills [fig.7], on the caudal end of the dorsal aspect of the last segment are two tufts of five or six long hairs; ventrad of which is a bunch of four very short processes. The anal feet are about as long as the 11th segment, each one with a crown of 12 to 15 bifid claws, resembling the one shown on plate 50, figure 9, but sharper, straighter and more slender, and the inner one comparatively shorter, the angle between the two teeth being about 60°.

The pupa [fig.12] is elongate, its abdomen eight segmented, not counting the anal appendage. The usual respiratory filaments of Chironomus, consist of a pair of much branched tufts. On the lateral margins of each of the segments are a few delicate, transparent filaments [fig.10]; of these there are five pairs on the eighth segment, besides a pair of chitinized toothed claws. On the margin of the anal segment is a close row of hairs, the basal portions of which are stout, but extremely fine at the extremity, where they become matted, forming a paddle [fig.10, 12].

Of course no adults were found in the material, but from some nearly mature pupae the flies were withdrawn, and these possess the following characters. Length, 7 to 8 mm. Dorsum of thorax brown, with the usual three dark dorsal stripes; pectus darker brown; dorsum of abdomen paler brown, the incisures whitish; the ventral surface of each segment with a large, rectangular brown spot, the rest whitish; legs yellowish brown; the tips of all joints blackish. Metatarsus longer than the preceding joint; all tarsal claws simple. Male genitalia complex, consisting of two pairs of blunt lobes, the outer pair the longer; a pair of two jointed claws; and on the dorsal aspect is a single large, heavily chitinized, downward curved hook. Figure 11 shows a side view, the dorsal surface being turned uppermost. The colors given in the above description are doubtless intensified in the living fly. It is hoped that by means of this description the fly may later be recognized.

THALASSOMYIA Schiner

Plate 50, fig.1-15

Verh. Zool. Bot. Ver. 6:216, 1856

This is the first record of the genus from North America. As far as I am aware, but two species have been described, T. frauenfeldi Schiner and T. congregata Tomasovary, both European species. The genus belongs to the group Chironomus (*sens. lat.*); but differs from all the other genera of this group in having the fourth tarsal joint shorter than the fifth [fig.14], resembling in this respect Tanypus, and Diamesa, from which it differs in the wing venation; the R–M cross vein wanting; antennae as in Chironomus.

T. obscura n. sp.

This fly was very common here during the past summer, the larva living on the rocky bottom of the shallow, swiftly flowing streams, where the water is but an inch or two in depth [pl.32], sometimes in company with Simulium; it spins a loose cocoon so open and transparent that the larva is not hidden by it, though it prevents the larva from being washed away.

Male. Front and epistome yellow, palpi fuscous, shorter than the antennae, its first joint about one and one half times as long as broad, the second twice, the third three times and the fourth about four times as long as the first. Antennae fuscous, 14 jointed, the first disklike, the second longer than broad, the third to the 13th about as long as broad, the 14th longer than all the others taken together; all furnished with long brown hairs except the apical one fourth of the 14th. Dorsum of the thorax blackish. Yellow on the humeri and pleura, covered with a white bloom, most conspicuous on the humeri. The dorsum of the thorax has a dirty yellow ground color but the three black longitudinal stripes are so wide that only a little of the ground color shows, excepting on the humeri and the two very narrow faint longitudinal stripes separating the three wide, black ones. The scutellum is chestnut; metathorax black; pectus brown; abdomen dull black, the dorsum of the first two segments greenish; the extreme edge of each segment, paler fuscous; the venter greenish, darker, almost black on the more posterior segments. The green is sharply separated from the dorsal color on a lateral line. In dried specimens this green color becomes dusky. Legs almost black, the coxae and bases of the femora yellowish, tarsal claws simple; wings hyaline, hairless, the anterior veins yellowish, the rest hyaline; venation as in the figure; anterior and posterior margin delicately ciliate; genitalia inconspicuous [fig.13, dorsal view]. Halteres white. Length 3 to 5 mm.

Female. Antennae seven jointed, black, with short hairs. Thorax with the black stripes a little narrower than in the male, hence the yellow stripes separating them and those on the humeri, more conspicuous. Pectus, scutellum, and a little space in front of the latter, brown; the pectus in dried specimens sometimes nearly black; pleura yellow, metanotum black; abdomen as with the male, but the venter paler, legs black, coxae and base of femora yellow; tarsal claws simple; wings hyaline, anterior margin and tip a little smoky; anterior veins yellow; wing margins delicately ciliate; venation as with the male; halteres white. Length 3 to 5 mm.

Larva. The eggs I did not find. The larva is 8 to 10mm in length when full grown, pale or yellowish green in color, its head dark brown and heavily chitinized. The head is somewhat longer than wide, the dorsal suture well marked, and with a few setae arranged as in figure 4. Two setae are placed immediately in front of the transverse suture, and at the apical end of the labrum are two more [fig.4]. A ventral view of the labrum is given in figure 3; *e* representing the epipharynx to which perhaps belongs also the two lateral pieces with their pointed processes. The anterior margin is furnished with a number of small fleshy lobes. The antennae are small, the basal joints about four times as long as wide, with two terminal pieces, one of which is four jointed, the other simple [fig.1]. The mandibles [fig.2] are about twice as long as broad, heavily chitinized, and with five short, blunt terminal teeth; articulated at the base of each is a long slender piece, with four terminal spines. This is shown folded down in the figure. The maxillae are short protuberances, covered with pointed processes; a very short palpus with terminal papillae, and two stout setae projecting ventrad. The hypopharynx [fig.5] is tonguelike, with two long basal pieces. Its apex and its dorsal surface are covered with pointed papillae; ventrally, there is an open arched rib. At the cephalic end of the ventral sclerite and coalescent with it, is the labium, with 11 blunt marginal teeth, the middle one wide and broadly truncated. On the prothoracic segment are the two prolegs, each with about 30 long, curved spines, and a number of small and very short spines on the ventral surface. At the base is a single slender seta, on each side a little dorsad of the lateral line are two more, and caudad of these and below the lateral line a group of three. The 11th segment is without blood gills; the 12th with two comparatively short legs, each with a crown of eight to 10 bifid claws [fig.9, 12]; dorsad of which are two tufts of five or six bristles each. Between the prolegs and projecting caudad are four short blood gills.

Pupa. The pupa is about 4½mm long, with the colors of the adult. It is much shorter in comparison to its breadth than that of Chironomus (*sens. str.*). The wings extend to little beyond the posterior margin of the second abdominal segment. Eight segments are present besides the short anal segment. On the dorsum of each segment, toward the caudal margin, is a transverse band of stout, black bristles. Each band is composed of five or six rows. The arrangement of these bristles (the longest of which are about one third as long as an abdominal segment) is shown in figure 11. The anal segment is composed of two lobes with a single apical bristle. After two to four days of pupal life, it transforms into the adult.

Genus DIAMESA Meigen

This genus has long been known to occur in Greenland, but has not, till now, been recorded from the United States. In 1898, Lundbeck described three new species from Greenland, one of which, D. aberrata, he considers the species which Staeger erroneously (?) identified as D. waltlii.

Antennae of the female eight jointed, the basal disklike, the intermediate ones rounded, the last cylindrical. Antennae of the males usually plumose and 14 jointed. Eyes oval; the front wide and flat. The eyes and the wings resemble Tanypus. The cell M is separated from the cell M $_{1+2+3}$ by a cross vein, as in Tanypus. The fourth tarsal joint is shorter than the fifth.

Diamesa Waltlii Meigen

1838 D. waltlii Meigen, Syst. Beschr. 7:13, 1

1846 nivoriundus Fitch (Chironomus), Winter Insects of Eastern New York nec Orthocladius nivoriundus Johnson, (?) Cat. of New Jersey Diptera

This fly occurs, sometimes abundantly, in this State from January to April. Fitch's description is rather indeterminate, but I believe it to belong to the species which is described below. I have compared it with specimens from Europe, with which it agrees in all particulars. According to Lundbeck [*Diptera Groclandica*, 1898], D. Waltlii does not possess cilia on the posterior margin of the wing, he quoting Meigen as authority; the European specimens which I have do have these cilia, as do also the American specimens; and I therefore believe that aberrata Lundbeck is also a synonym.

Male. Black. Head black, including eyes, mouth parts and antennae, the latter densely covered with long, dark brown hair. Its first joint enlarged, disklike, the second twice as long as broad, the following 11 a little shorter than broad, the 14th longer than all the rest taken together. The palpi are somewhat shorter than the antennae, four jointed (besides a small basal piece), the first joint shorter, the fourth longer than the other two. Dorsum of the thorax black, subshining, with a faint cinereous bloom, covering the surface excepting the three slightly raised longitudinal stripes, which are deep black, and on which are arranged some scattered black setae; scutellum dark brown, with black setae; metanotum and pleura black, the latter with a gray bloom; abdomen black, longer than the wings in fresh specimens, covered with fine brown or black hairs, posterior margins of the segments narrowly cinereous.

Genitalia conspicuous and rather complex [pl.47, fig.8 dorsal, fig.10 ventral, view]. The apical joint of the appendages, triangular in outline with a sharp point; the basal joint with a pointed process attached near its base on the inner side, mesad of which are two smaller pointed projections. The dorsal spur is nearly straight and spikelike. Legs uniformly fuscous, all the fourth tarsal joints shorter than the fifth, tarsal claws simple. Wings broad, and nearly as long as the abdomen in fresh specimens; usually longer than abdomen in dried specimens; cinereous in color, the anterior veins conspicuous, brownish or black; media and cubitus pale, posterior margin very delicately ciliate. Halteres usually pale, in some specimens pale brownish, the knob triangular in outline. Length 3.5 to 5mm.

Female. Cinereous black, front and epistome cinereous, eyes but slightly excavated at base of antennae; palpi and antennae fuscous, the latter with eight joints counting the disklike basal joint, short haired [fig.7]; scutellum hemispherical, dark brown, with black setae; abdomen fuscous with short brown hairs, posterior margin of the segments darker except on the extreme edge, which is pale yellow; genitalia small, brown and leaflike; legs fuscous; claws simple; wings broad, and longer than the abdomen; anterior veins black; media and cubitus pale; venation as in the figure. Length 3.5 to 5 mm. All else as with the male. Described from bred and captured specimens.

Larva [pl.48, fig.9–13]. The larvae were taken in company with the larvae of Thalassomyia fusca among the algae on the surface of rocks over which the water flows rapidly. In its pale green color, its general appearance, and even in many details it greatly resembles Thalassomyia fusca. The dorsal sclerite of the head is shaped like that of the last mentioned species shown on plate 50, figure 4; with two pair of marginal setae, but the hindmost pair are situated farther back than in Thalassomyia fusca. On the lateral sclerite there is one seta near the base of the mandible just above the lateral line, one pair below this one and a little cephalad; another pair about one fourth of the length of the head caudad of these but lying as far below the lateral line as the first is above. Directly caudad of the first, but midway between the front and hind margin of the head, is another. Close to the dorsal suture, one fourth the length of the head cephalad of the caudal margin, is still another; and finally there is a single one on each side at the base of the labium [fig.10].

The ventral surface of the labrum is shown in figure 9. The hypopharynx resembles that shown in plate 50, figure 5; and the maxilla that shown in figure 6. The epipharynx is as shown on plate 48, figure 9*e*, its free end having four to six filaments, the apical pair being stoutest. This member may be bent forward and the filaments then spread out, fanlike. The "jointed appendages" [fig.9*j*] are well developed; each is apically expanded into a handlike process with seven or eight "fingers." These appendages are attached at a point near the anterior margin of the labrum. The mandibles [fig.12] have each five blunt teeth, a fringe of coarse branched hairs projecting mesad, and two stout setae on the dorsal surface near the base. The labium [fig.10] possesses about 19 blunt teeth, no suture being visible between it and the lateral (or ventral?) sclerite. The antennae are of moderate length [fig.11] and bare, with three terminal, jointed appendages. The thoracic and abdominal feet are as on plate 50, figures 7 and 12; but the abdominal legs appear a little longer in proportion to their diameter. The entire body of the larva is almost devoid of hairs excepting the caudal tuft.

Pupa [fig.13]. The pupa is of a fuscous color with a greenish tinge; its thorax is apparently without either tracheal gills or breathing tube. On the dorsal posterior margins of each of the abdominal segments excepting the first and last there are 10 to 12 short, stout, caudad projecting teeth, the two or three lying nearest the lateral margin being smaller than those more dorsad; and on the ventral posterior margin of the abdominal segments excepting the first, second and last there are six or eight stout teeth projecting cephalad. At the anal end of the last segment are three pairs of short hollow filaments, which may have a respiratory function. The length of pupal life is about two days.

This pupa greatly resembles that of Diamesa culicoides as figured by Heeger in Sitzb. d. k. Akad. d. Wiss. Wien., 1853, excepting that in the latter there are eight caudal filaments instead of six.

Described from specimens taken in Cascadilla creek, Ithaca N. Y., April 1902.

Part 7

SIALIDIDAE OF NORTH AND SOUTH AMERICA

BY K. C. DAVIS

The study leading to the preparation of this paper was made chiefly while the writer was a graduate student at Cornell University, 1898-1900. The writer is under great obligation to Prof. J. H. Comstock and Mr A. D. MacGillivray, of Cornell, for much aid and encouragement; to Mr Samuel Henshaw, of the Museum of Comparative Zoology, for use of the rich collections made by Dr Hagen and others; to Mr William H. Ashmead for the examination and loan of valuable specimens from the United States National Museum; to Dr Henry Skinner for kindness shown while examining specimens in the Philadelphia Academy of Natural Sciences; and to a number of correspondents and others who have given information in regard to distribution, or lent specimens for examination, or aided in other ways.

The family Sialididae is of peculiar interest both on account of the large size and the striking appearance of most of its members and because it includes some of the most generalized members of the order Neuroptera.

As is often the case with more primitive groups, the family is a small one, including only four living genera; but it has a world-wide distribution. Fortunately for our purposes, all of the genera are found in our country, and representatives are common in many sections. The four genera are represented in the two Americas by only 32 species.

Family SIALIDIDAE

The members of this family differ from all other Neuroptera in having the hind wings broad at the base, the anal area being folded like a fan when the insect is at rest. They differ from their nearest allies, the Raphididae, in the form of the prothorax, which is quadrangular, while in the Raphididae it is generally elongated. They also differ from most other Neuroptera in being aquatic in their larval state.

Though the family contains only four living genera, these represent two quite distinct lines of development. So well marked are these that they may be considered as representing two subfamilies, which may be designated as the Sialidinae and the Corydalinae. The more important of the distinctive characters of the subfamilies are included in the following tables.

TABLE TO SUBFAMILIES

Adults

a Accessory veins of radial sector on the front side of vein R_3 [fig. 23]; ocelli wanting; fourth segment of tarsi prominently bilobed .... Sialidinae

aa Accessory veins of radial sector on the posterior side of vein R_2 [fig. 24, 25, 26]; ocelli three; fourth segment of tarsi obscurely or not at all lobed......... Corydalinae

Larvae

a Anal prolegs wanting; lateral filaments only seven pairs, and distinctly jointed....................... Sialidinae

aa Anal prolegs one pair, provided with claws; lateral filaments eight pairs, slightly or not at all jointed. Corydalinae

Egg masses

a Eggs always in one layer [pl.51]................. Sialidinae

aa Eggs in more than one layer [pl.52]................ Corydalinae

Eggs

a Distal portion of micropylar projection cylindric, twice as long as broad, joined to the egg by a short neck [fig.20].... .... Sialidinae

aa Distal portion of micropylar projection nearly globular, joined to the egg by a long neck [fig.20]...... Corydalinae

Subfamily SIALIDINAE

The adult members of this subfamily are all much smaller than those of the Corydalinae; the ocelli are wanting; the accessory veins of the radial sector in both pairs of wings arise from R_3 and extend forward, giving the insect a very characteristic mode of flight; the fourth segment of the tarsi is prominently two lobed.

The subfamily includes a single genus Sialis.

SIALIS Latreille

Besides the characters of the subfamily given above, the following additional generic characters should be added:

Adult. Body and wings black or ferruginous; prothorax quadrangular, almost equal in width to the head, not so long as the mesothorax and metathorax combined; ocelli wanting; antennae filiform, about equal to the body in length; wing expanse 20 to 40 mm, hind wings somewhat less.

The males are usually a little smaller than the females.

Larva. Suited for aquatic life. 20 to 30 mm long when full grown; tapering from head to the caudal end of abdomen; head and thorax yellow on dorsal side, mesothorax and metathorax bearing some light brown markings; the appendages of the head and the eyes brown; abdominal segments brown on the dorsal side and somewhat on the ventral side; first seven segments of the abdomen each supplied with a pair of five jointed, lateral appendages, evidently tracheal gills, each with two rows of delicate hairs [fig. 20]; within these thin, white walled, gill appendages are seen finely divided trachea; from the last abdominal segment is a single caudal appendage similar to but longer than the lateral ones and not jointed and supplied with *two* large branching trachea and *four* rows of delicate hairs. This structure may indicate, as Miall has suggested, that the caudal appendage may have been formed by the fusion of two lateral appendages. There is a pair of minute spiracles present on each abdominal segment except the last. Each antenna has five segments, but the basal one if often obscure.

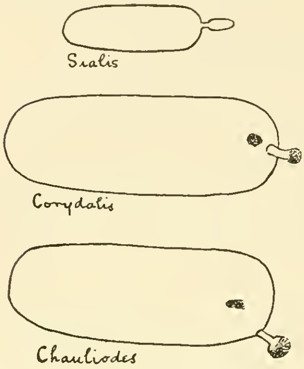

Fig. 20 Eggs of Sialididae

On the dorsal side of the larva of S. infumata the segments are translucent, often showing the viscera. The lateral lobes of the abdominal segments are so transparent that the particles of blood may be seen and the pulsations of the heart may be counted. I found the number of pulsations to vary somewhat, but the average is about 10 a minute. Oenocytes with the finest branches of tracheoles leading to them are so plainly visible that they can be photographed.

Eggs. The eggs of S. lutaria, the most common species in Europe, have been briefly described by Miall [1895] as "dark brown, several hundred in one cluster, cylindrical with rounded ends, and closely packed together; from the free end of each egg a small, pointed and whitish projection is given off." The eggs of our most common species, S. infumata, have been found in great numbers. They agree with the above description. The "whitish projection," or micropylar projection, is not knobbed at the end, but the distal portion, which may be the micropylar surface, is cylindric in form, with a short, narrow pedicel at the point of attachment to the eggshell.

The masses are often quadrangular but are variable in outline, and are not coated with any protecting material. Several masses are very commonly found near each other; in one case about 150 masses were found within an area 6 by 12 inches; and the remains of the masses of former years are also found near the fresh eggs if the place be a suitable one. The eggs are all placed in a slanting position, i. e. not perpendicular to the surface of attachment; and are all parallel to each other, in one layer, with the micropylar projection outward. Exact counts and estimates show that the number of eggs in a mass is usually from 200 to 500 [pl. 51].

Life history of Sialis infumata

It is an interesting sight to see a female depositing her eggs. This I have witnessed on several occasions. She deposits an entire row of 10 to 20 eggs and then begins another row; as the rows accumulate, she moves backward over the mass to reach the place for the succeeding rows; thus her body and wings cover the egg mass till it is completed. The eggs are always deposited over water or in a place where the young larvae will naturally fall into water. I found them on the under sides of boat landings, on the under and vertical sides of bridges, on stones projecting above the water of creeks and lakes. Stagnant pools are not attractive to members of this genus. The adults do not seem to select the twigs or leaves of trees and shrubs when such objects as those above mentioned are accessible. When a high bridge is selected by the adults, on which to deposit their eggs, they know where the limits of the running water are, and deposit the eggs within those limits.

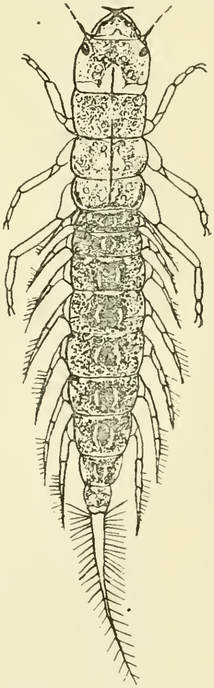

Fig. 21 Larva of Sialis infumata x3 (After Needham)

After seeing females deposit their eggs and after noting the dates when other new eggs were deposited, say on a given rock, it was an easy matter to determine the length of the egg period. By visiting the region daily till the hatching took place, the period was found to be nine or ten days. Hatching seems to take place only in the dark. In the region of Ithaca in 1899, the hatching took place mostly during the first half of June. It was observed that many masses of eggs never hatch. Some masses of old eggs, apparently dried and dead, were found to hatch when placed in a moist bottle in the collector's pocket. In several cases these were found to hatch within an hour from the time they were taken. The only explanation is that they had become too dry, and the moisture in the bottle helped to soften the eggshells so that the young larvae could break through.

Larva. The young larvae when hatched differ somewhat in appearance and structure from the older larvae above described, specially in having relatively longer filaments and legs, and larger heads with larger mouth parts and only two jointed antennae.

Miall [1895], who has made a study of S. lutarius, states that the larvae live about a year in streams with muddy bottoms. My observation of S. infumata indicates that the larval life is at least two years. However, the exact length is yet to be determined more certainly. Miall states that he found freshly hatched larvae of his species "wriggling out on leaves many yards from the nearest stream or pond." I have seen nothing like this, as S. infumata always places the eggs where the young when hatched will fall directly into the water.

The larvae live in the bottoms of streams which are either muddy or sandy. I have most often found them in deep sand or gravel, perhaps 6 inches or a foot below the bed of the stream. At this depth the larvae of Corydalis, perhaps their worst enemies, seldom find them. Tests made as to their food habits show that they are carnivorous, and will eat soft bodied caddis worms, small Chauliodes larvae and even eat one another very readily. The larvae do not come to the surface nor abandon their aquatic life till nearly ready to pupate. When captured, they often eject a black liquid from the mouth. This means of defense is much more commonly used by them than by the larvae of Chauliodes and Corydalis.

Pupa. The pupae of this species have only once been found in their natural conditions by the writer. Prof. J. H. Comstock first found them buried several inches in the earth some yards from water [fig. 22]. Miall's observations of S. lutaria quite agree with this, and he further states that the adult emerges after two or three weeks.

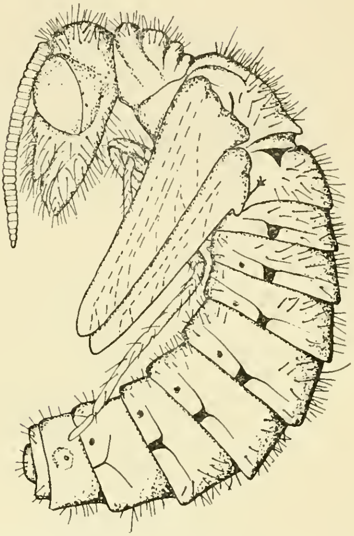

Fig. 22 Pupa of Sialis infumata x3 (After Needham)

Adults. These have already been described above. They are very awkward fliers and are easily caught even without a net. This quite agrees with the generalized form of the wing venation [fig. 23]. In fact, the adults when approached, will often run rather than attempt to fly. It is probable that the insect lives in the winged form only a few days. All specimens taken were found to die within three days. The dates on which the adults have been collected near Ithaca range from May 13 to June 16, through a series of years. They are diurnal in their habits and seem to prefer bright sunshine. I have found them most abundantly in their egg-laying places at midday, though they also frequent the same places and are active till almost dark.

The short life taken with the fact that the mouth parts of the adult are very poorly developed, would indicate that the adults do not take food. It was reported to Dr Hagen and to the national museum some years ago that the adults of S. nevadensis were very injurious to grapevine leaves. This is the only case of injury yet charged to any members of the family, and may be a false charge. On the other hand, the adults, flying near the surface of water, serve as an abundant supply of food for fishes.

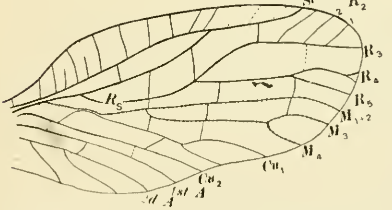

Fig. 23 Fore wing of Sialis infumata x4

KEY TO SPECIES OF SIALIS

a Body and wings black or blackish
  b Head black with flat, shining streaks and spots yellowish

c The proximal cross vein between R_1 and R_s opposite the proximal cross veins between R_s and M; fore wings rarely with more than two accessory veins arising from R_3; cheeks yellowish .... 1 infumata

cc The proximal cross veins between R_1 and R_s distinctly distad of the proximal cross vein between R_s and M, and which is generally opposite the first fork of media; fore wing never with less than three accessory veins arising from R_3; cheeks black............... 2 fuliginosa

bb Head black in front with a broad orange band behind .... 3 nevadensis

aa Body either black or ferruginous, wings pale ferruginous, or pale fuscous

b Head black in front, with broad orange band behind; body black........................... 4 morrisoni

bb Head yellow, orange, or reddish, with or without dark markings; body never quite black

c Front of head without dark stripes............ 5 americana

cc Front of head marked with black stripes, or suffused with fuscous

d Antennae stout, head with two black stripes; femora yellowish; eyes normal............ 6 bifasciata

dd Antennae slender; head with a long median line, suffused with fuscous in front; femora blackish fuscous; eyes unusually prominent 7 chilensis

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 S. infumata Newman

1838 Sialis infumata Newman, Ent. Mag. 5:500
1853 Sialis infumata Walker, Cat. Brit. Mus. Neur. p.195
1861 Sialis infumata Hagen, Synopsis Neur. N. Am. p.188
1863 Sialis infumata Hagen, Ent. Soc. Phila. Proc. 2:181
1863 Sialis infumata Walsh, Ent. Soc. Phila. Proc. 2:261
1892 Sialis infumata Banks, Am. Ent. Soc. Trans. 19:357
1897 Sialis concava Banks, Am. Ent. Soc. Trans. 24:22
1901 Sialis infumata Needham, N. Y. State Mus. Bul. 47, p.542, pl.29

Black; head a little narrower than the prothorax, but not narrowed posteriorly, between the eyes convex to concave, caudal half of head with ferruginous and shining streaks and spots, similar spots between the eyes, more or less conspicuous; antennae black, rather slender; prothorax rounded on the anterior angles, the sides of dorsal aspect with a few impressed points; legs and feet black; wings nearly black, the veins thick and blacker; R_3 of fore wings with rarely more than two simple or forked branches; the proximal cross veins of R_1-R_s and R_s-M are opposite. Length to tip of wings 10 to 15 mm; alar expanse 22 to 26 mm. Males are the smaller.

S. concava Banks was said to differ in being always concave between the eyes. This, however, is not a constant character as shown by an examination of hundreds of specimens. Fourteen specimens in the Harvard collection under this label are apparently males of S. infumata.

A species of very wide distribution: arctic America, Quebec, Nova Scotia, throughout New England and New York, New Jersey, Maryland, Washington D. C., Washington N. C., Ohio, Detroit Mich., Galena and Galesburg Ill., Saskatchewan region, in Minnesota at Minneapolis and St Cloud, in California at Lake Tahoe, Placer co., San Geronimo, San Celito.

2 S. fuliginosa Pictet

1836 Sialis fuliginosa Pictet, Ann. Sci. Nat. pl.3, fig.6
1839 Sialis fuliginosa Burmeister, Handb. Ent. 2:947
1856 Sialis fuliginosa Brauer, Verh. Zool. Bot. Ges. p.397
1857 Sialis fuliginosa Brauer & Low, Neur. Aust. p.52
1865 Sialis fuliginosa McLachlan, Ent. Mo. Mag. 2:107, fig.1; and 1866, 3:95
1868 Sialis fuliginosa McLachlan, Ent. Soc. Lond. Trans. 152:8, fig.2

This European species, not formerly reported in America, differs from S. infumata in several points: larger, the alar expanse of the female being 38mm and the three brown spots between the antennae relatively much larger; much more densely pilose throughout, even slightly so on the hind wings; compound eyes ferruginous with several black spots or areas; the proximal cross vein R_1-R_s is distinctly distad of the proximal cross vein R_s-M, the latter generally opposite the first fork of media. In S. infumata the yellow infusion around the eyes is usually quite distinct, while in S. fuliginosa it is much less so. Fore wings never with less than three accessory veins arising from R_3; these are either simple or forked.

Six specimens collected by Morrison 1878, Reno Nev., one from Morris county, Cal., two from Mendocino Cal., and two from Webber lake, Cal., agree with this characterization, and are like the European specimens in the Museum of Comparative Zoology.

3 S. nevadensis n. sp.

Body black; head not narrowed behind, black with orange band clear across the caudal half and reaching around under the eyes to the antennae, smooth streaks and spots of the same color in the orange band above, no such spots between the antennae; eyes black; prothorax hardly narrower than the head, black, not at all marked with the orange color, anterior angles obtuse; antennae black, very slender; feet and legs black; legs pilose; wings black, translucent, either shining or dull, veins darker if possible; Sc-R_1 cross veins only one or two; R_3 with two simple or forked branches. Length to tip of wings 18 to 25 mm; alar expanse 38 to 40 mm.

Collected by Morrison at Reno Nev., 1878. In Nevada county, Cal., June 12, 1880, said to be " very injurious to grapevine," or " injuring grape leaves." Types in United States National Museum catalogue no. 5177.

4 S. morrisoni n. sp.

Body black; head and thorax shaped and marked as in S. nevadensis; legs and feet ferruginous; wings ferruginous, veins hardly darker; venation as in that species. Length to tip of wings 20mm; alar expanse 40mm.

Collected by Morrison, Reno Nev., 1878. Type in Museum of Comparative Zoology.

5 S. americana Rambur

1842 Semblis americana Rambur, Hist. Nat. Neur. p.447
1853 Sialis ferrugineus Walker, Cat. Brit. Mus. Neur. p.195
1861 Sialis americana Hagen, Synopsis Neur. N. Am. p.188
1892 Sialis americana Banks, Am. Ent. Soc. Trans. 19:357

General color ferruginous; head narrower behind; eyes black; caudal half of head with flat streaks and spots shining and surrounded with ferruginous; antennae ferruginous; anterior angles of prothorax square; prothorax a little narrower than the head, sides with yellowish impressed punctures; femora ferruginous; feet fuscous; wings pale ferruginous, the veins darker; R_3 only one branched; Sc-R_1 cross vein only one. Length to tip of wings 12 to 14 mm; alar expanse 24 to 26 mm.

Reported from Georgia and Pennsylvania. One specimen in the Museum of Comparative Zoology. Hagen [1861] is my authority for placing the name given by Walker as synonymous with the above.

6 S. bifasciata Hagen

1861 Sialis bifasciata Hagen, Synopsis Neur. N. Am. p.188

General color ferruginous; head not narrowed posteriorly, color orange with two broad, black stripes, shining orange streaks and spots behind; antennae stout, black, pilose; prothorax orange, anterior angles obtuse, sides with broad fuscous somewhat shining stripe and flat points; femora yellowish with base fuscous; feet fuscous; wings pale fuscous, somewhat shining, front ones obscure on costal margin, veins pale fuscous. Length to tip of wings 10 to 12 mm; alar expanse 17 to 20 mm.

Cuba.

7 S. chilensis McLachlan

1870 Sialis chilensis McLachlan. Ent. Mo. Mag. 7:145

Fusco-nigra, abdomen black; head reddish, an impressed median longitudinal line reaching the hind margin, joining a sinuate line in front, before the antennae, frontal part and at sides of median line suffused fuscous, a fuscous spot on each side below the eyes; labrum truncate in front, testaceous; eyes larger and much more prominent than in other species; thorax blackish fuscous, very narrow, clothed with a short pubescence; antennae and palpi black; legs and feet blackish fuscous, short pubescent; claws and beneath lobes of fourth tarsal joints testaceous; wings smoky, somewhat shining, membrane with short, black hairs, pale space in each wing below the juncture of R with Sc; veins black, costal area narrow, slightly dilated, with about seven C-Sc cross veins, R_3 with but one forked branch; front wings long and narrow, apex long elliptic; hind pair slightly broader.

Chile.

S. lutaria Linn. is the most common European member of the genus. There are seven specimens in the Hagen collection. The alar expanse of the males is 25 mm and of the females 35 mm. The antennae are nearly equal to the expanded fore wings but are variable. The compound eyes are marked about as in S. fuliginosa. The species is much like S. infumata in most particulars, but there are only one or two Sc-R_1 cross veins of the fore wings; R_3 has two simple or forked branches going forward, and there is no yellow infusion spreading around the eyes; the legs are ferruginous, not black. Larvae in alcohol have abdomen black with a row of yellow markings down the middle of the dorsal side. The pupa has no abdominal appendages, and is very light yellow all over, and has a whorl of hairs over each abdominal segment.

S. sibirica McLachlan. Four specimens with this label are in the Hagen collection, but they do not differ from the specimens of S. lutaria.

Subfamily CORYDALINAE

Here we find the accessory veins of the radial sector in both pairs of wings arising from R_2 and extending backward. The insects are provided with three ocelli. The tarsi are not at all lobed or sometimes slightly so. Anal prolegs and claws are present in the larvae. Three genera are included in this subfamily, Chauliodes, Neuromus, and Corydalis.

TABLES TO GENERA

Adults

a Mandibles when closed largely concealed by the labrum; mandibles of male hardly more elongated than those of the female; white dots rarely found within the cells of the wings
  b Media of the fore wings with only two branches [fig.24]; lateral margins of the head not toothed [pl.52]....Chauliodes
  bb Media of the fore wings always with more than two branches [fig.25]; lateral margin of the head bidentate or unidentate or only slightly unidentate in N. corripens....................................Neuromus
aa Mandibles when closed not concealed by the labrum; mandibles of male enormously elongated; white dots always found in some of the cells of the fore wings..........Corydalis

Larvae

a Tracheal gills wanting; last pair of spiracles raised on prominent conical folds or long respiratory tubes.........Chauliodes

aa Tracheal gills on ventral side of the first seven abdominal segments; last pair of spiracles not raised on respiratory tubes nor on conical folds
  b Antennae with five segments........................Neuromus
  bb Antennae with six segments........................Corydalis

Egg masses[1]

a Mass not covered..Chauliodes
aa Mass normally covered with a whitish coat of albuminous matter ....Corydalis

Eggs

a Micropylar projection distinctly at one side of apex; neck less than half the width of micropylar surface [fig.20]...Chauliodes
aa Micropylar projection near the apex; neck nearly as broad as micropylar surface [fig.20]............................Corydalis

CHAULIODES Latreille

Adult. Smaller than Corydalis; body 20 to 40 mm long, the male often being smaller than the female. Prothorax quadrangular, narrower than the head, and shorter than the mesothorax and metathorax combined; no toothed angle on sides of the head; three large approximate ocelli facing at about 120° from each other; antennae moniliform serrate, pectinate, or flabellate; mandibles not prominent, concealed by the labrum when closed; wings numerously veined, the accessory veins of the radial sector extend backward from R_2 in both pairs of wings; radial sector with four to six branches, and medius always with only two branches [fig. 24]; cross veins between all the branches of radius varying in different species, from seven to about 20; hind wings broad at base and folded in the anal area when at rest; alar expanse 50 to 90 mm; tarsi cylindric, five jointed; caudal appendages conical, stout, inferior pair often simple in both sexes, superior pair simple in female and slightly prehensile in male.

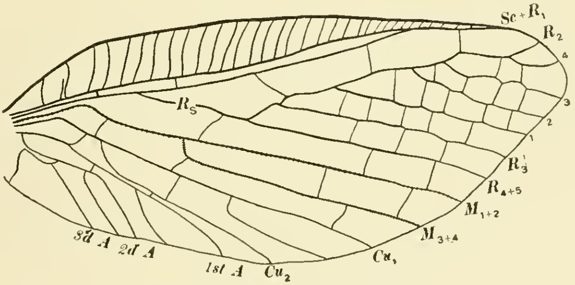

Fig. 24 Fore wing of Chauliodes x3

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[1] Eggs of Neuromus have never been described.

Larva. Aquatic; about half as large as the larva of Corydalis when full grown; dark fuscous with black or dark head and prothorax; clavate projections on the skin present, similar to those found on larva of Corydalis, but of a light brown color and much less distinct. Last four or five segments of the abdomen tapering toward the caudal end of the body; first eight segments of the abdomen each with a pair of whitish lateral filaments 6 to 8 mm long, which may serve as tracheal gills in the younger larvae; these are sometimes indistinctly five jointed and are sometimes only slightly clothed with hairs; no ventral tufts of tracheal gills present; spiracles are found on a fold between the prothorax and the mesothorax and on each of the first eight abdominal segments, the last pair being raised more or less on prominent conical folds or terminating a pair of slender tubes. These tubes, in the species where they are present, are very contractile and vary in length at times from about 5 to 12 mm [*see* Lintner, 1893, pl.1]. On the last segment is a pair of anal prolegs, each with a pair of claws and a lateral filament which is decidedly hairy; antennae with five segments, the first segment often being retracted.

Several larvae in the Museum of Comparative Zoology are much like the ones I have formerly collected. Eight collected at Cambridge have no central black stripe on dorsal aspect of abdomen and thorax. One sent by H. Edwards from California has last pair of spiracles nearly sessile. The lateral filaments are unusually long and rather distinctly jointed. Specimens collected in Kentucky by Sanborn have last pair of spiracles nearly sessile, and the last pair of lateral filaments very long, reaching much past the anal ones. The last pair of respiratory tubes are clearly shown, and are confluent or adjacent at their base on specimens collected at Brookline by Mr Henshaw.

Eggs. The eggs of Chauliodes have been described and photographed by Dr Needham [1901]. Riley [1879] briefly compared them with eggs of Corydalis in these words: “Eggs of Chauliodes have a larger tubercle or stem on the top, and are not covered with white, albuminous material as are those of Corydalis.” These are the only references to the eggs which I have found in literature.

The masses are shaped not unlike the masses of Corydalis eggs, but are more variable in size and shape. They are reddish brown, with no protective coating over the mass. The eggs of a mass are usually placed in three layers of unequal size, the smallest layer being on top; the longer axis of each egg is parallel to the surface to which the mass is attached [pl. 52, fig. 2].

The brown or pink micropylar projection is knobbed, and is placed a little to one side of one end of the egg; otherwise the egg is cylindric, with rounded ends [fig. 20].

Life history of Chauliodes

The eggs were first found by the writer on the underside of a boat landing built of wood, on the southeast shore of Cayuga lake near Ithaca N. Y., June 14, 1899, while searching for them. In this case there was but a single mass, freshly deposited within two feet of the surface of the water. The second lot, found June 16th in Coy glen, was composed of three groups or clusters, each cluster being made up of about 30 or 40 egg masses. Each mass has from 1000 to 2000 eggs. These were all within a radius of 2 feet on a large glacial rock, about 2 or 3 feet above running water. Farther up the glen in many places I found single masses on small rocks overhanging the water. Some of these were 10 or 15 feet above the water. In one case a mass was found on an overhanging limb of a tree. Mr A. D. MacGillivray has frequently found them on leaves and limbs. Stones seem to be preferred by the adults when depositing their eggs.

The hatching takes place at night, five or six days after the eggs are deposited. The young larva breaks from the egg at the end near the micropylar projection, which is the cephalic end of the embryo, and readily finds its way to the water, usually by dropping directly from the egg mass or the object to which it is attached.

The freshly hatched insect differs from the more mature larva in having the lateral filaments relatively much longer, and the head larger; and the antennae only two segmented.

The young are not very active and will remain in the portion of the stream below the egg mass for several months or probably longer if not carried away by the strong current. A muddy bottom is not distasteful to them, though they may be found in many parts of our common streams; they are less frequently found in the swiftest parts. The species (C. serricornis) with the long caudal breathing tubes have been found only in stagnant or quiet water.

The larvae are carnivorous, and do their feeding chiefly in the dark. The large larvae readily eat smaller ones of their own species, and larvae of Sialis, caddis worms, small dipterous larvae, and other accessible forms with soft bodies. Weed [1889] says that a larva in an aquarium ate Notonecta undulata, house flies, and a spider.

The length of the larval period has not been definitely determined. It may be judged from the data already known that it is about three years. The amount of increase at each molt, if found from a number of examples, would furnish data for determining the number of molts. The number of molts compared with the average time between molts would determine rather closely the larval period. The great difficulty in the way of determining the number and average time of the molts, is that they can not easily be cared for and fed in their exact natural conditions through a long period and their increase at each molt carefully measured. Larvae if fed well will doubtless molt more rapidly than those which are poorly fed. I kept larvae alive in running water from Sep. 2, 1899, to June 1, 1900. Only two of them molted during that period, but they were very poorly fed.

Young larvae which hatched June 15 to 20, 1899, over a quiet part of a brook where the bottom was a large, flat rock deeply covered with sediment, were found in great numbers and of nearly uniform size four months later, at the close of the warm season. It is from these and from the range of sizes observed at one place as the result of one day's collecting, that I have thought the larval period must be about three years.

When fully fed and of proper age, the larva leaves the water, makes a cell in rotten wood, in the earth, or under a stone or even in mud, where it sheds the last larval skin to assume the pupal form.

The pupae are difficult to find, as they are often far from water and may be buried several inches in the ground. The length of the pupal stage has not yet been exactly determined, but the period is probably not longer than two weeks. Walsh and Weed both mention C. rastricornis, as being found under bark of the upper side of logs floating in water. They were doubtless there to pupate. Weed speaks of the pupa stage of that species as lasting eight days in one case and 14 days in another case. H. L. Moody [1878] notes that a specimen of C. pectinicornis spent 12 days in the pupa stage.

The pupae are quiescent but can crawl when disturbed. The color is at first light brown but becomes dark before the emergence of the adult insect. As in the case of Sialis and Corydalis, the pupae very much resemble the adults in many points of external structure. Walsh says of pupae of C. rastricornis, that at least the female has two robust obtuse abdominal appendages, about 2mm long, confluent at base; and an inferior process of two similar ones, connate throughout.

The adults are better fliers than Sialis, but are still very awkward and are not difficult to catch. They are chiefly crepuscular, but often fly in the late morning, and are easily frightened from their diurnal hiding places along a wooded stream. Specimens taken to cages have all died in a very short time, and it is probable that the life in the winged state is only a few days. They have not been known to take food in this state.

Adults of C. serricornis have been collected at Ithaca from June 9 to 18 in various years.

KEY TO SPECIES OF CHAULIODES

a Wings black or brown with white markings
  b A continuous, broad, somewhat arcuate white band extending across the middle of each wing almost attaining the hind margin of each; antennae serrate in the female, flabellate in the male .... 1 fasciatus
  bb An irregular band of white spots, generally broadest in front, extending across the middle of each front wing, on the hind wing represented by only a few minute dots which may be wanting; antennae more or less serrate in both sexes [pl.52]............................ 2 serricornis

aa Wings somewhat ashy in color with more or less dusky markings
  - *b* Veins of fore wings marked with dark and light uniformly alternate
    - *c* Antennae of both sexes serrate; prothorax with pale line in middle behind..................3 rastricornis
    - *cc* Antennae of both sexes pectinated..........4 pectinicornis
  - *bb* Veins of fore wings uniform in color except where the dusky markings cross them
    - *c* Head yellow behind by the confluence of the smooth areas
      - *d* Antennae brown........................5 angusticollis
      - *dd* Antennae blackish.......................... 6 concolor
    - *cc* Head with the smooth areas dark brown or blackish
      - *d* Antennae black; alar expanse 50 to 65 mm.. 7 minimus
      - *dd* Antennae brown; alar expanse 75 to 100 mm
        - *e* Area about ocelli much depressed; antennae of male about equal in length to head and thorax; those of female much shorter .... 8 disjunctus
        - *ee* Area about ocelli not depressed; antennae of male densely bristly, as long as body..9 californicus

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 C. fasciatus Walker

1853 Chauliodes fasciatus Walker, Cat. Brit. Mus. Neur. p.201

1861 Chauliodes serricornis Hagen, Synopsis Neur. N. Am. p.190

1863 Chauliodes lunatus Hagen, Ent. Soc. Phila. Proc. 2:180

1863 Chauliodes lunatus Walsh, Ent. Soc. Phila. Proc. 2:262

1869 Chauliodes fasciatus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40

1892 Chauliodes lunatus Banks, Am. Ent. Soc. Trans. 19:357

General color dark brown or black; head rufous, the disk fuscous, head of male more slender and more highly colored, back of head with flat, rufous streaks; prothorax with impressed rufous spot each side, that of the male more slender and more highly colored; legs luteofuscous, tarsi duller in color; antennae black, serrate in female, flabellate in male, each joint with a large oval plate underneath; wings brownish black, fore pair with a broad white band, pointed with fuscous, not attaining the posterior margin; one or more apical marginal spots, some cross veins bordered with white; posterior pair with a broad arcuate white band not attaining the posterior margin, and a large rounded basal white spot, also a small apical spot and sometimes the cross veins bordered with white. Length to tip of wings 35 to 40 mm; alar expanse 60 to 70 mm. The males are the more highly colored on the head and thorax, and the dark part of their wings is more uniformly black.

The inferior appendage of the male is elongated, narrower at tip, and of a pale brown color. The males are the smaller.

When the wings of this species are spread, the white arc across their center is nearly continuous from one to the other.

New York, Pennsylvania, Glen Echo D. C., Maryland, Sugar Grove O., Illinois, Lake of the Woods, Missouri, Arkansas, Mexico.

2 C. serricornis Say

1824 Chauliodes serricornis Say, Long's Exp. 2:307

1839 Chauliodes serricornis Burmeister, Handb. Ent. 2:949

1842 Neuromus maculatus Rambur, Hist. Nat. Neur. p.442, pl.10, fig.2

1853 Hermes maculatus Walker, Cat. Brit. Mus. Neur. p.202

1859 Chauliodes serricornis Say, Am. Ent. LeConte ed. 1:206

1861 Chauliodes maculatus Hagen, Synopsis Neur. N. Am. p.191

1863 Chauliodes serricornis Hagen, Ent. Soc. Phila. Proc. 2:180

1863 Chauliodes serricornis Walsh, Ent. Soc. Phila. Proc. 2:262

1869 Chauliodes serricornis McLachlan, Ann. and Mag. Nat. Hist. (4) 4:40

1892 Chauliodes serricornis Banks, Am. Ent. Soc. Trans. 19:357

1892 Chauliodes serricornis Say, Banks, Am. Ent. Soc. Trans. 19:357

1901 Chauliodes serricornis Needham, N. Y. State Mus. Bul. 47, p.549, pl.27

Body black; back of head with flat, ferruginous streaks and spots which are sometimes black; prothorax fuscous, impressed each side; legs and feet nigro-fuscous; antennae serrate in both sexes; inferior appendage of male is of a shining black at tip; wings black, a transverse interrupted white line in middle of front wings, widest at anterior margin, not attaining the posterior margin; hind wings in middle with a few minute white dots which may be wanting; some white apical spots in both wings, these often united in hind wing to form larger white apical areas. Length to tip of wings 30 to 38 mm; alar expanse 45 to 55 mm [pl.52, fig.1].

Massachusetts, New York, Pennsylvania, Washington D. C., Maryland, Georgia; in Ohio along tributaries of the Muskingum in Knox county; in Minnesota at St Cloud, St Johns and Minneapolis.

3 C. rastricornis Rambur

1842 Chauliodes rastricornis Rambur, Hist. Nat. Neur. p.444
1853 Chauliodes rastricornis Walker, Cat. Brit. Mus. Neur. p.198
1853 Hermes indecisus Walker, Cat. Brit. Mus. Neur. p.204
1861 Hermes pectinicornis Linnaeus, Hagen, Synopsis Neur. N. Am. p.189
1861 Chauliodes rastricornis Hagen, Synopsis Neur. N. Am. p.189
1863 Chauliodes rastricornis Hagen, Ent. Soc. Phila. Proc. 2:181
1863 Chauliodes rastricornis Walsh, Ent. Soc. Phila. Proc. 2:263
1869 Chauliodes rastricornis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40
1892 Chauliodes rastricornis Banks, Am. Ent. Soc. Trans. 19:357
1901 Chauliodes rastricornis Needham, N. Y. State Mus Bul. 47, p.546

General color luteo-cinereous; head behind with flat, black streaks and spots; prothorax with a slight impression on the middle behind, a flexuous impressed stripe each side; legs luteous, tarsi fuscous; antennae of both sexes serrate; front wings subcinereous, obscurely clouded with fuscous, veins marked with dark and light uniformly alternate; hind wings cinereous. Length to tip of wings 45 to 55 mm; length of body 5 to 50 mm; alar expanse 65 to 80 mm.

New York, Pennsylvania, South Carolina, Georgia, western Florida, Sullivan Ind., Illinois, Missouri.

4 C. pectinicornis Linnaeus

1763 Hemerobius pectinicornis Linnaeus, Amoen. Acad. 6:412 and Centures Insector, p.29, 87

1767 Hemerobius pectinicornis Linnaeus, Syst. Nat. ed. 12. p.911

1773 Hemerobius pectinicornis DeGeer, Mem. Ins. 3:562, t. 27, fig.3

1773 Hemerobius virginiensis Drury, Ill. Nat. Hist. v.2, Apx.

1775 Hemerobius pectinicornis Fabricius, Syst. Ent. p.309

1781 Semblis pectinicornis Fabricius, Sp. Ins. 1:386; and 1787. Mantissa Ins. 1:244; and 1793. Entom. Syst. 2:72.

1805-21 Hemerobius pectinicornis Palisot, Ins. Afr. and Am. Neur. t. 1, fig.2

1807 Chauliodes pectinicornis Latreille, Gen. Crust. and Ins. 3:198

1836-49 Chauliodes pectinicornis Cuvier, Règne Animal, p.14; t. 105, fig.2

1837 Hemerobius pectinicornis Drury, Ins. Westw. ed. 1:105, t. 46, fig.3

1839 Chauliodes pectinicornis Burmeister, Handb. Ent. 2:950

1842 Chauliodes pectinicornis Rambur, Hist. Nat. Neur. p.444

1853 Chauliodes pectinicornis Walker, Cat. Brit. Mus. Neur. p.198

1861 Chauliodes pectinicornis Hagen, Synopsis Neur. N. Am. p.189

1861 Chauliodes virginensis Hagen, Synopsis Neur. N. Am. p.190

1869 Chauliodes pectinicornis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40

1869 Chauliodes virginiensis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40

1892 Chauliodes pectinicornis Banks, Am. Ent. Soc. Trans. 19:357

1892 Chauliodes virginiensis Banks, Am. Ent. Soc. Trans. 19:357

1901 Chauliodes pectinicornis Needham, N. Y. State Mus. Bul. 47, p.547; also pl.26, fig.1 (erroneously named)

General color luteo-cinereous; hind part of head with yellowish, flat streaks and spots; prothorax with a middle stripe behind yellowish, and a yellow flexuous stripe each side; legs yellowish, tarsi fuscous; antennae fuscous, pectinated; front wings grayish, often obscurely clouded, transversely streaked with fuscous; veins fuscous, uniformly interrupted with white; radial sector with six or seven branches; hind wings grayish; cross veins between all the branches of radius in front wings, about 20 to 22. Length to tip of wings 45 to 60 mm; alar expanse 58 to 90 mm. The female is the larger.

New England, New York, Ohio, Detroit Mich., Wisconsin, central Missouri, Maryland, Virginia, South Carolina, Florida, Louisiana.

5 C. angusticollis Hagen

1861 Chauliodes angusticollis Hagen, Synopsis Neur. N. Am. p.191

1869 Chauliodes angusticollis McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40

1892 Chauliodes angusticollis Banks, Am. Ent. Soc. Trans. 19:357

General color fusco-testaceous; mandibles yellow; head small, yellow behind by the smooth spots and streaks blending together, black across between the eyes; ocelli yellowish white; prothorax narrow, a fulvous stripe in the middle posteriorly and a lateral one each side; legs fuscous; antennae of female nearly filiform, brown; those of male nearly moniliform, clothed with brown bristles, the two basal joints nearly smooth; appendages of male stout, obtuse, oblique; wings gray much marked with brownish black points and patches scattered over the front wings and costal and distal areas of the hind ones; cross veins between all the branches of radius in front wings, about nine to 11; radial sector of same pair with four to five branches. Length to tip of wings 35 to 42 mm; alar expanse 55 to 70 mm.

Georgia, Virginia, Kentucky, Illinois.

6 C. concolor n. sp.

Body dusky; head light yellow behind by the fusing of the smooth shining stripes and areas; prothorax longer than wide, narrower than the head; a brown median line behind, and irregular brown marks each side; ocelli light colored; antennae nearly black, rather long, nearly moniliform, clothed with short bristles beyond the basal joint; legs brown, feet dusky; wings cinereous with numerous small dusky markings, specially on front pair and costal area of hind pair; veins mostly dark and each of nearly uniform color throughout; a transverse dusky line near base of front wings; in the front pair, cross veins between all the branches of radius, about seven to 10, and radial sector with five branches. Length to tip of wings 45 to 55 mm; alar expanse 70 to 85 mm.

Ithaca N. Y. The dates on all specimens in Cornell collection, so far as they are dated, are in the latter half of July.

The species is most like C. californicus in general appearance, but differs in color of the hind part of the head, color of the antennae and feet, and in other minor points.

7 **C. minimus** n. sp.

Body color blackish; mandibles black; head small, black, with smooth raised streaks and spots behind black; prothorax black, very narrow, smooth raised places almost wanting; legs and feet black; antennae very slender, filiform to moniliform, black, nearly equaling the body in length; wings much like those of C. californicus in color and markings; the front pair with cross veins between all branches of radius, about seven, and radial sector divided into five branches. Length to tip of wings about 28 to 35 mm; alar expanse 50 to 65 mm.

San Rafael Cal. Types in Museum of Comparative Zoology.

8 **C. disjunctus** Walker

1866 Chauliodes disjunctus Walker, Lord's Naturalist in Vancouver isl. 2:334

1869 Chauliodes disjunctus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40

General color brown, often with cinereous hairs; mandibles with black tips; head dark rufous, thickly punctured, hind part with long, shining, dark streaks, some of which are not continuous; prothorax rather long and much narrower than the mesothorax; legs lightest toward the body, varying in color from blackish to yellowish brown; antennae very short, brown, pilose; wings cinereous, with numerous dark brown spots and dots, some of which form incomplete transverse lines most marked on front wings; that pair with some of the spots collected into about five costal patches, some very dense basal spots; radial sector of front wings with five to six branches; cross veins between all the branches of radius, about seven to nine. Length to tip of wings 75 to 90 mm; alar expanse 90 to 125 mm. This species includes the largest members of the genus found in the new world.

Vancouver island; in California at San José, and near Alder Creek, Sacramento co.

9 C. californicus Walker

1853 Chauliodes californicus Walker, Cat. Brit. Mus. Neur. p.199

1861 Chauliodes californicus Hagen, Synopsis Neur. N. Am. p.190

1869 Chauliodes californicus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:40

1892 Chauliodes californicus Banks, Am. Ent. Soc. Trans. 19:357

Body brownish black; mouth parts rufous, mandibles often with only one tooth below the apex; hind part of head rufous with flat, somewhat shining streaks and spots; prothorax behind with a flexuous, obsolete, rufous stripe, the middle elevated and more obsolete; legs brown; antennae brown, stout, long as body in male, much longer than head and thorax in female; those of the male densely covered with bristles, giving a feathered appearance; two basal joints naked; wings cinereous, veins of front pair transversely lined with the fuscous markings of the cells which cross them; from costal margin of all the wings a basal brownish black streak, and sometimes apical ones; other brown spots often present, specially on the front wings; in front pair, cross veins between all the branches of radius, about seven to nine; and radial sector with five branches. Length to tip of wings 45 to 60 mm; alar expanse 75 to 100 mm.

Mariposa and in Siskiyou county, Cal. and Reno Nev.

10 C. cinerasceous Blanchard

1851 Chauliodes cinerasceous Blanchard, Gay, Hist. Chile, v.6, Neur. pl.2, fig.10

1861 Chauliodes chilensis Hagen, Synopsis Neur. N. Am. p.321 *(nomen nudum)*

1869 Chauliodes cinerasceous Blanchard, McLachlan, Ann. and Mag. Nat. Hist. (4), 4:41

General color ashy; head pale variegated; prothorax rugose, a pale line behind; legs and feet same color as abdomen, wings cinereous, front pair dusky spotted all over, spots minute and more obscure at costal margin, some spots larger; hind pair slightly spotted. Length of body 20mm. (The figure measures 26mm); length to tip of wings about 55mm; alar expanse 75 to 80mm.

In Chile at Valparaiso and Valdivia. Blanchard said, *Esta especie parece rara en Chile.*

I have seen no specimens of this species, and therefore I quote Blanchard's description:

Ch. omnino cinerasceus; capite pallido-variegato; prothorace rugoso, linea postica pallida; alis cinereis, anticis undique fusco-maculatis, maculis minutis margine costali obscurioribus, nonnullis majoribus; alis posticis leviter maculatis; pedibus abdomineque concoloribus. Longit., corpor. 10 lin; enverg. alar., 30 lin.

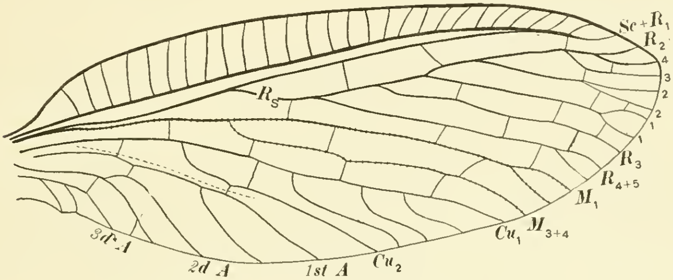

Fig. 25 Fore wing of Neuromus pallidus x2

Hagen afterward said his species equals C. cinerasceous Blanchard.

NEUROMUS Rambur

Adult. Color from nearly black to light yellow; usually somewhat smaller than Corydalis adults; mandibles of male never elongated nor annular as in Corydalis. Cheek once or twice toothed or with a sharp angle. Prothorax quadrangular to cylindric, narrower than the head, longer than broad and shorter than the mesothorax and the metathorax combined. Three large approximate ocelli facing outward. Antennae always filiform or nearly so, and usually not longer than the head and thorax combined. Medius with more than two branches [fig.25]; cross veins between branches of radius, from 10 to 30, but the number is rather constant in each species; Cu_1 with one or two accessories in some species, to four or five in others.

Larva. No published account of Neuromus larvae has appeared. They are doubtless very rare in the United States, and when found have probably been mistaken for larvae of Corydalis.

There are two lots, or 14 unnamed specimens, from the Himalaya region, in the Museum of Comparative Zoology, sent from Kullu, by M. M. Carleton, a missionary, some years ago. (One lot dated 1872). These I consider are larvae of Neuromus, as they differ materially from the Corydalis larvae so familiar to us, and as adult specimens of Neuromus were sent by the same collector from the same region, and Corydalis has never been reported from that part of Asia.

They are distinguished from Corydalis (1) by the *black* ring about the spiracles; (2) by the antennae being only five jointed as in Chauliodes larvae; (3) by the abdominal gill tufts being more distinctly peduncled.

They have eight pairs of abdominal spiracles, one well developed pair and one rudimentary pair on the thorax; seven pairs of tracheal gill tufts. The body above is very black with the clavate projections. These are found distributed over the more flexible parts of the body and filaments. Lateral filaments eight pairs, with a row of tufted hairs on dorsal side of six front pairs, more tufts on the others. The head and thorax are dark without distinct markings. Prothorax longer than wide and as wide as the head; eyes each with six ocelli; labial palpi with three joints above the base.

The larvae appear much like those of Chauliodes, but the presence of the tracheal gill tufts excludes them from that genus, while the black ring and center of each spiracle, as well as the five jointed antennae, separate them quickly from Corydalis.

Eggs. The eggs of this genus have never yet been recognized, but we would expect them to be most like those of Corydalis.

TABLE TO SPECIES OF NEUROMUS

a Sides of head with alate bidentate process....	1 soror
aa Sides of head only once toothed or only slightly angled	
b Front wings with white dots in most of the cells back of the costal region...........	2 cephalotes
bb Front wings not marked as above	
c Head black, wings brown in distal half...	3 maculipinnis
cc Head and body yellowish; wings mostly yellowish; dark markings on the prothorax	
d Front wings spotted with black or brown posteriorly, and with their cross veins mostly dark; metathorax often marked with black or brown..	4 hieroglyphicus

dd Front wings not spotted with dark; cross veins dark or not; metathorax not marked with black or brown
- *e* Cross veins of fore wings more or less darkened (brown or black)
  - *f* Dark markings on prothorax distinct; media of fore wings with six branches; cross veins between all branches of radius, 25 to 30. . 5 corripiens
  - *ff* Dark markings on prothorax indistinct; media of fore wings with 3 (?) branches; cross veins between all branches of radius, 10 to 12. . . . . 6 winthemi
- *ee* Cross veins of fore wings not darkened 7 pallidus

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 N. soror Hagen

1861 Corydalis soror Hagen, Synopsis Neur. N. Am. p.193

General color luteous; mandibles brown; cheeks with alate bidentate process; head broad, not depressed, a brownish stripe each side; prothorax narrower than head, longer than broad, each side with a brownish border; legs lurid with knees and apex of tarsi obscurer; antennae short, slender, black, the two basal segments yellowish; appendages of male four, superior ones forcipated, clavate at apex; inferior ones cylindric, extremely short; wings luteo-subhyaline, an obsolete band on the middle of front pair, and fuscous spots nearer the apex; veins fuscous, luteous on the middle of the costal space; cross veins between all branches of radius, about 18 to 21; medius of fore wing four branched; Cu_1 with four to five accessories. Length to tip of wings 60 to 75mm; alar expanse 85 to 130mm.

Mexico, Cordova.

2 N. cephalotes Rambur

1842 Corydalis cephalotes Rambur, Hist. Nat. Neur. p.441
1853 Corydalis cephalotes Walker, Cat. Brit. Mus. Neur. p.208
1861 Corydalis affinis Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)
1866 Corydalis hecate McLachlan, Jour. of Ent. 2:499, pl.20

Color of body dark brown, mandibles and mouth parts reddish brown; head dark brown, roughened behind but not marked with lighter color; cheek with sharp tooth; prothorax longer than broad, blackish brown, hastate groove same color; femora dusky, tibiae and tarsi yellowish; antennae slender, filiform, brownish yellow, blackish at tips, about equal to head and thorax in length; appendages of male four, superior pair thin, nearly flat, not angled at the end, shorter than the inferior ones; wings dull brown with white dots in cells, and mostly black on costal region of front pair, and white areas in stigma and back of medius in middle of wing; cross veins mostly dark, even in the costal region; mediums of fore wing with four to five branches; cross veins between all branches of radius about 18 or 19; Cu_1 with three to four accessories. Length to tip of wings 70 to 80 mm; alar expanse 105 to 145 mm.

Brazil.

3 N. maculipinnis Gray

1832 Hermes maculipinnis Gray, Griffith's ed. of Cuvier, 2:331, pl.72, fig.1
1842 Neuromus ruficollis Rambur, Hist. Nat. Neur. p.443
1853 Hermes ruficollis Walker, Cat. Brit. Mus. Neur. p.202
1853 Hermes maculifera Walker, Cat. Brit. Mus. Neur. p.203
1861 Corydalis illota Hagen, Synopsis Neur. N. Am. p. 321 (*nomen nudum*)
1869 Hermes maculipinnis Gray, McLachlan, Ann. and Mag. Nat. Hist. (4), 4:39

Nearly black; mandibles black; sides of head convex, toothed angle wanting, only slightly angled on each side, back of head with black or brown shining streaks and dots, two long streaks in center, other smaller ones each side; prothorax narrower than head, longer than broad, lurid, darker at each side of center; legs and feet ferruginous; antennae longer than the thorax, slender, slightly serrated in both sexes; wings ferruginous, hyaline, white in basal part of both pairs, or in the front pair the two colors are mixed toward the base; a white spot in radiomedial region about three fourths the way out; other white spots and blotches between these spots and the white areas; media of fore wing with six branches; cross veins between all branches of radius, about 18 to 30; Cu_1 with two accessories in both pairs of wings of both sexes. Length to tip of wings 38 to 48 mm; alar expanse 65 to 80 mm.

Brazil.

4 N. hieroglyphicus Rambur

1842 Neuromus hieroglyphicus Rambur, Hist. Nat. Neur. p.442

1853 Hermes hieroglyphicus Walker, Cat. Brit. Mus. Neur. p.206

1861 Corydalis hieroglyphicus Hagen, Synopsis Neur. N. Am. p.194

1869 Neuromus hieroglyphicus McLachlan, Ann. and Mag. Nat. Hist. (4), 4:45

Pale yellow; mandibles brown; cheeks convex, one toothed; head with two black spots behind, which fade out in some specimens; prothorax cylindric with four black or brown spots or marks; mesothorax with sometimes two to four similar marks; feet yellow, base and apex of tibiae and apex of tarsi black; antennae short, black with bases yellow; appendages of male four, superior ones the longer, apex recurved; inferior ones stout, apex clavated; wings yellowish hyaline, cross veins in front pair partly black, and those wings marked posteriorly with more or less distinct black spots; media of fore wings with three branches; cross veins between all branches of radius, about 10 to 17; Cu_1 with 1 to 2 accessories. Length to tip of wings 40 to 65 mm; alar expanse 65 to 90 mm.

Mexico, Central America, Brazil, Venezuela.

5 N. corripiens Walker

1860 Hermes corripiens Walker, Ent. Soc. Lond. Trans. n. s. 5:180

1861 Corydalis livida Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)

1869 Neuromus corripiens McLachlan, Ann. and Mag. Nat. Hist. (4), 4:45

General color testaceous; mandibles black, marked with dark brown; head black between the ocelli; heads slightly angled; prothorax narrower than the head, almost linear; two elongated black dots on each side, the fore pair sometimes almost obsolete; legs yellow above, darker below, tarsi blackish; antennae simple, black, testaceous toward the base; wings whitish hyaline, veins testaceous, fore pair with the cross veins more or less black, costa very convex; media of fore wings with six branches; cross veins between all branches of radius, about 28 to 30; Cu_1 with three accessories. Length to tip of wings 60 to 65 mm; alar expanse 90mm.

Brazil.

6 N. winthemi n. sp.

Yellowish; mandibles reddish brown; head brownish yellow, lighter on hind part, side of head one toothed; prothorax longer than broad, dark marking indistinct; legs light yellow, last tarsal segment blackish; antennae not seen; wings whitish hyaline; veins yellow; fore pair with the cross veins and angles of veins more or less brown; cross veins between all branches of radius about 11 or 12; Cu_1 with two accessories. Length of body 32mm; to tip of wings 55mm; alar expanse 90mm.

Brazil. Collected by Winthem. Type in the Hagen collection, Museum of Comparative Zoology.

7 N. pallidus n. sp.

Light yellow; mandibles brownish; ocelli partly ringed with black; behind each side of head a brown raised mark; cheek with a single tooth; prothorax longer than wide, a brown interrupted streak each side, not reaching the caudal margin of the segment; legs and feet light yellow, claws darker; antennae filiform and hairy; wings transparent, obscured in the stigmatal region of all four wings; a few white scales and hairs along the veins; cross veins, at least toward base of fore wings, somewhat darkened; about 12 to 14 cross veins between all the branches of radius; media of fore wings with three branches; Cu_1 with two accessories. Length to tip of wings about 40mm; alar expanse 60 to 65 mm [pl. 52, fig. 3].

Type in United States National Museum, Washington, catalogue no. 5176; probably native of Mexico.

CORYDALIS Latreille

Adult. This genus includes the largest insects of the order. Yellow-fuscous, 40 to 60 mm long from base of jaws to end of abdomen, males usually the larger; wings fuscous with black and yellow veins; white dots always found in some of the cells of the fore wings. Prothorax quadrangular, much narrower than the head and shorter than the mesothorax and the metathorax combined; large toothlike angles on the back part of the sides of the head; three large approximate ocelli facing at about 120° from each other; antennae filiform moniliform or slightly serrate in a few species, as long as, or much longer than the head and thorax combined; mandibles prominent, not concealed by the labrum when closed, those of the male more or less elongated and annular, incurved, suited only for clasping. Wings numerously veined, the accessory veins of the radial sector extending backward from R_2 in both pairs of wings, and media has more than two branches [fig. 26]; hind wings broad at base and folded in the anal area when at rest; wing expanse 100 to 150mm. Tarsi cylindric; male caudal appendages long and usually strongly forcipate; in the female they are short and simple.

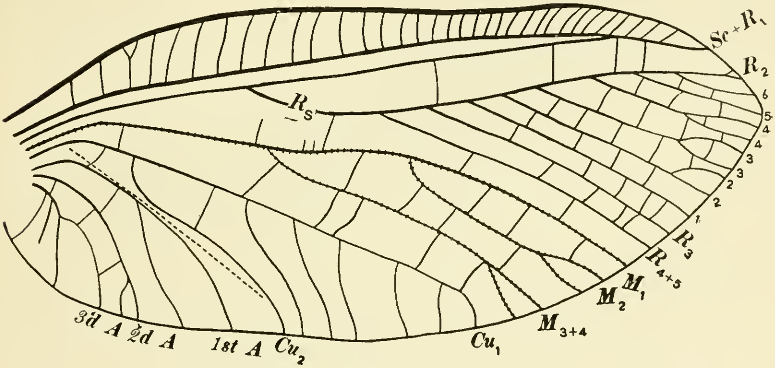

Fig. 26 Fore wing of Corydalis cornuta x2

Larva. When full grown, the larva is about 80 to 90 mm long. The general color is dusky; the head and thorax are supplied above with pretty figured markings; the whole body is supplied with black clavate projections except in the intersegmental folds and on the parts heavily clothed with chitin. The last four or five segments of the abdomen taper toward the caudal end of the body. The first eight segments of the abdomen are each provided with a pair of unjointed lateral filaments, 6 to 7 mm long, somewhat clothed with hairs; the first seven of these segments are each provided with a pair of ventral tufts of tracheal gills. Spiracles are found on each of the first eight abdominal segments and on the fold between the prothorax and the mesothorax, and a rudimentary pair on a fold between the mesothorax and the metathorax. On the last abdominal segment are a pair of slightly two jointed anal prolegs, each with a pair of strong, slender claws and a lateral filament. The antennae have six segments, the basal joint being united with the head, though Walsh and Riley recognized only five segments.

Corydalis larvae collected from different localities have been examined. As they show some variations, a few notes on them may aid in future work of determining the species.

Label, "Colorado, Chiquili, Dr Newbery, 1873." Has no tufts of hairs on the lateral nor anal filaments. The spongy tufts are sessile as in C. cornuta. Some tufts of hairs near the spiracles on the sides of the abdomen; some yellow markings on dorsal aspect of abdomen.

Label, "Texas, Stolley, no. 1640." Has two rows of hairy tufts on most of the lateral and on the anal filaments. Thorax and head brown with some light yellow areas; abdomen dark above with no yellow markings; mesothorax and metathorax same color as the prothorax.

Label, "Mobile Ala., 1853." Has tufts the same as the above specimen, but the abdomen is very dark, and the clavate projections are usually long. Mesothorax and metathorax same color as the abdomen; prothorax and head reddish brown without the striking light markings; lateral and caudal filaments nearly white above.

Label, "Rio Negro, Amazon, Thayer Exp." (about 1869). Has the six jointed antennae. and the marks of C. cornuta on the head and thorax. It differs from that species in that the spongy tufts stand out ventrally from the abdomen, as a pair of fan-shaped tufts to each segment.

Label, "Himalaya, Sutlej river, Billispur M. M. Carleton, 1872." Very light brown or yellowish; reddish yellow on the thorax and head. The eight pairs of lateral filaments are clothed on the ventral side with tufts appearing like the tracheal tufts. A similar growth fringes the abdominal segments. Antennae six jointed; ocelli six on each side.

Eggs. The egg masses of Corydalis cornuta were described by Riley [1877] who found them in the middle of July 1876, along the banks of the Mississippi. His description I quote:

"The egg mass of Corydalis cornuta is either broadly oval, circular, or (more exceptionally) even pyriform in circumference, flat on the attached side, and plano-convex on the exposed side. It averages 21mm in length, and is covered with a white or cream-colored albuminous secretion, which is generally splashed around the mass on the leaf or other object of attachment. It contains from two to three thousand eggs, each of which is 1.3mm long, and about one third as wide, ellipsoidal, translucent, sordid white, with a delicate shell, and surrounded and separated from the adjoining eggs by a thin layer of the same white albuminous material which covers the whole. The outer layer forms a compact arch, with the anterior ends pointing inward, and the posterior ends showing like faint dots through the white covering. Those of the marginal row lie flat on the attached surface; the others gradually diverge outwardly so that the central ones are at right angles with said object. Beneath this mantled layer the rest lie on a plane with the leaf, those touching it in concentric rows; the rest packed in irregularly. Before hatching, the dark eyes of the embryon show distinctly through the delicate shell, and the eggs assume a darker color, which contrasts more strongly with the white intervening matter.

The egg-burster (*ruptor ovi*) has the form of the common immature mushroom, and is easily perceived on the end of the vacated shell."

Prof. Riley's description of the "egg-burster" agrees exactly with the appearance of the micropylar projection, and this is the only appendage I have found on the eggs either before or after the larvae have hatched [fig.20].

The eggs are found on trees, vines, leaves, stones, bridges, etc, usually over running water, but sometimes at a very short distance to one side of the stream.

Life history of Corydalis cornuta

Riley and others have given accounts of the life history of this species, but by careful tracing I have been able to add a few points.

The young larvae of an egg mass all hatch in a single night, crawl from under the mass and soon drop or crawl to water. The young differ from the older larvae in having relatively larger heads and mouth parts, only three jointed antennae, and relatively longer filaments and legs. Riley observed that they lack the ventral spongy tracheal tufts. These tufts do not appear till a later molt. Riley therefore concluded that these tufts are for the purpose of adhering to stones, and not for breathing. The structure of these (showing tracheae), the absence of other suitable gills, the regular movements of the tufts when a larva is actively respiring, as when placed in water from which the air has escaped—all these indicate the true purpose of the tufts.

The larvae live at the bottom of streams of rapid water in the swiftest parts, under stones. They readily feed on soft bodied caddis worms, Sialis larvae, very young Chauliodes larvae, younger members of their own species; and doubtless have a wide range of food habits. I have succeeded in getting hungry larvae to eat bits of fresh beef by placing them in a tray of water in a photographic dark room. They do not feed well when exposed to bright light; and they seem to prefer live food. In the dark room they will sometimes eat large dipterous larvae.

They spend the winter some distance below the bed of the stream buried in the sand and gravel.

The larvae usually crawl when they care to move about in the water, but they can swim backward readily and sometimes are found to swim forward.

Nothing very definite is known as to the number of molts or as to the length of the larval period. The same problems are here involved as those stated on a preceding page in speaking of Chauliodes larvae. I have kept larvae of Corydalis over winter in running water in dark cells made of flowerpots. Out of 28 which were kept alive in the cells for nine months, only two were found to molt, and these do not warrant the drawing of any general conclusion. In September 1899 I took from one locality in Fall creek, Ithaca, over 100 larvae and measured their heads. The range of sizes was so gradual that it gave no clue to the probable number of years represented in the lot.

Though the larvae naturally live in beds of streams till full grown, they are capable of living out of water in moist soil for an indefinite length of time. I thus kept them in a breeding cage in a greenhouse for over four months, at the end of which they were accidentally killed. The larval spiracles are doubtless open and functional, at least when the insect is out of water, and may be used for breathing from air which collects under stones in running water.

The mature larvae leave the water in May or June and pupate in cavities under flat stones near the stream. At times they crawl for many rods and even up high banks before selecting a suitable place to pass the pupa state. Walsh gives an account of the crawling of the mature larvae to the top of a chimney of a small house by the Mississippi river.

When the last larval skin is shed, the pupa is very light brown or nearly white, but gradually becomes darker up to the end of the period. The pupa very much resembles the adult in external structure, specially as regards the antennae, tarsal segments, wing pads, and absence of lateral filaments, spongy tufts and prolegs. There is great variation in the appearance of the warty prominences left by the bases of the filaments.

The length of the pupal life was determined by daily observation of specimens which had just crawled from the water to find a nest for the pupal life. The transformations of 25 specimens were thus noted. It was found that the time spent in the nest before the larval skin is shed varies from about one day to as much as two weeks. The time from this last molt till the adult emerges, or the actual life of the pupa, is not so variable, as the table will show.

No of larvae observed	Date of molting larval skin	Date of emerging as adults	Days in pupal life
4	May 29	June 8	10
5	May 28	June 4	7
12	May 29	June 7	9
2	June 7	June 14	7
1	June 9	June 23	14
1	June 12	June 26	14

It will be noticed from the table that the length of life in this state varies from seven to 14 days with an average of nine days in the specimens observed. Many (perhaps 10 or 15) others, which I observed, died during that state. This was probably partly due to the fact that they were handled too much, or became too dry in the cages where they were kept, but I have often found dead pupae under stones on banks of streams.

The adults are perhaps as good fliers as Chauliodes, and both of these will make longer flights than Sialis; both are often found at great distance from streams, while Sialis seldom wanders far from water. Corydalis is usually crepuscular, and is often attracted to lights at night. One large female was seen to make a flight of several rods, when apparently unmolested, on a bright, hot June day at 2 o'clock p. m.

The adults are very short-lived, at least when kept in cages, and probably also when at large, judging from the short length of the season when adults are to be found. Of the specimens kept in cages, the males never lived longer than three days after emerging, while the females lived as long as eight or 10 days. None could be induced to take food, and it is probable that the adults take no food. The studies made by Mr W. A. Riley and others indicate that very little histolysis takes place in the digestive organs. This is explained by the probable fact that these organs are not used in the adult insect.

The dates on which adult specimens have been taken at Ithaca range from June 4 to July 8, in a long series of years.

TABLE TO SPECIES OF CORYDALIS

a Hastate or lanceolate pale mark on middle of hind part of prothorax, irregular light marks each side	
b Costal cells of front wings mostly with two white spots in each	
c Male appendages, upper pair, with the ends abruptly turned under and back, appearing as a separate segment....................	1 inamabilis
cc Male appendages, with upper pair not abruptly turned backward	2 cornuta
bb Costal cells of front wings with only one white spot in each..............................	3 cognata
aa Hastate and other marks on prothorax of same color as the rest or nearly so	
b Antennae with two basal joints and most of the others light yellow, outer three fourths with minute sharp teeth	
c Front wings with no dusky clouds in cells, except near the stigmatal region; white dots almost wanting	4 crassicornis
cc Front wings with dusky and white clouds; white dots numerous except in costal region..	5 peruviana
bb Antennae with basal joints never yellow; segments of antennae never toothed	
c Costal cells often with two white dots in each	
d Front wings hardly clouded except in region of stigma	6 lutea

dd Front wings densely clouded in many places, specially just back of R_1.........	7 batesii
cc Costal cells with only one or no white dots	
d Front wings with dark circle near the forking of media; triangular white spot at stigma	8 nubila
dd Front wings not marked as above.........	9 armata

DESCRIPTION AND GEOGRAPHIC RANGE OF SPECIES

1 C. inamabilis McLachlan

1868 Corydalis inamabilis McLachlan, Linn. Soc. Jour. 9:235, pl.8, fig.3

Pale brown; abdomen pale fuscous; palpi black, with broad whitish yellow annulations; mandibles long, slender, finely rugose, pale brown with apical portion black; head yellowish brown, anterior margin nearly black; finely rugose above, beneath, and posteriorly with coarsely reticulated spaces; ocelli yellow; eyes plumbeous; caudal portion of head with impressed streaks and spots; prothorax longer than broad, slightly widened posteriorly; upper surface convex, pale brown, hastate median impression behind; roughened raised places along the sides; legs and feet pale yellowish brown, tarsi and tips of tibiae darker; antennae scarcely shorter than body, pale brown, three or four terminal joints black, basal joints bulbous, joints beyond basal fourth with a short triangular acute tooth; appendages of the male long, yellowish, slightly pilose; superior pair sinuate, the tips bent under and somewhat retuse; inferior pair geniculated, apexes directed upward and slightly dilated; wings long and narrow, subacute, cinereo-subhyaline; front pair with white dots in cells everywhere except in the costal area, Sc area with fuscous spaces, stigmatic region slightly yellowish, C–Sc cross veins black except those near the middle, which are whitish in the center; all discal and apical cross veins black; longitudinal veins yellow, subcosta and radius marked with fuscous; hind wings hardly paler, cross veins of discal and apical areas black, those in basal discal region yellow; front wings with about 26 cross veins between all branches of radius, media with four branches, Cu_1 with three accessories. Alar expanse 100mm; body without appendages 35mm; mandibles of male 26mm.

Waco and Dallas Tex.

2 C. cornuta Linnaeus

1758 Hemerobius cornutus Linnaeus, Syst. Nat. ed. 10. p.551
1767 Raphidia cornuta Linnaeus, Syst. Nat. ed. 12. p.916
1773 Hemerobius cornutus DeGeer, Mém. Ins. 3:559, pl.27, fig.1
1781 Hemerobius cornutus Fabricius, Sp. Ins. 1:392; and 1787. Mantissa Ins. 1:246
1788-93 Hemerobius cornutus Linnaeus, Syst. Nat. ed. 13. 5:2639
1791-1825 Corydalis cornuta Olivier, Encycl. Meth. 7:59
1793 Hemerobius cornutus Fabricius, Syst. Ent. 2:81
1805-21 Corydalis cornuta Palisot, Ins. Neur. pl.1, fig.1
1807 Corydalis cornuta Latreille, Gen. Crust. and Ins. 3:199
1836-49 Corydalis cornuta Cuvier, Règne Animal, p.14, pl.104
1839 Corydalis cornuta Burmeister, Handb. Ent. 2:950
1848 Corydalis cornutus Holdemon, Acad. Bost. Jour. p.158, pl.1-3
1861 Corydalis cornuta Hagen, Synopsis Neur. N. Am. p.192; 1863. Ent. Soc. Phila. Proc. 2:181
1863 Corydalis cornuta Walsh, Ent. Soc. Phila. Proc. 2:265
1892 Corydalis cornuta Banks, Am. Ent. Soc. Trans. 19:357
1901 Corydalis cornuta Needham, N. Y. State Mus. Bul. 47, p.550, pl.28

General color luteo-fuscous to luteo-cinereous: head large, broad, sides convex, hind part with impressed yellow spots and streaks surrounded by fuscous, each side with oblique yellow stripe beneath; mandibles never concealed by the labrum, those of the male normally much elongated and annulated; prothorax much narrower than head, longer than broad, a light colored hastate mark in the middle of the hind part, irregular yellow flat points each side; legs brownish, knees, apex and incisions of tarsi fuscous; antennae nearly moniliform, long, fuscous; superior pair of male appendages forcipated, infracted at the apex, dolabriform; wings subcinereo-hyaline; veins darker, often black, specially at their angles; C–Sc cross veins pale in middle; cells mostly supplied with white dots, the costal ones each with two white dots; in fore wing cross veins between all branches of radius, about 25 to 35, media with three to four branches, and Cu_1 with four to five accessories. Length to tip of wings about 75mm; alar expanse 100 to 140 mm. The size in both sexes is variable.

Quebec, New England, New York, Pennsylvania, Maryland, Washington D. C., Virginia, North Carolina, South Carolina, Ohio, Illinois, Missouri, Kansas, Minnesota.

3 C. cognata Hagen

1861 Corydalis cognata Hagen. Synopsis Neur. N. Am. p.193
1892 Corydalis cognata Banks, Am. Ent. Soc. Trans. 19:357

General color luteous yellow; head large, broad, sides convex, marked behind with two punctate ochraceous streaks, and a few obsolete points; prothorax almost quadrangular, a little narrower than the head, marked behind with a hastate mark in the middle and ochraceous points each side; feet and legs lurid, apex of tarsi obscurer, claws fuscous; wings yellowish hyaline, cross veins dark, front wings with a dark marking on base and apex of costal area, R_1 clouded fuscous, costal cells with one white dot, number of dots in other cells several, cross veins between all the branches of radius about nine to 11, medius with three branches, Cu_1 with three accessories. Length to tip of wings 55 to 60 mm; alar expanse 80 to 100 mm.

New Mexico, Phoenix Ariz.

4 C. crassicornis McLachlan

1868 Corydalis crassicornis McLachlan, Linn. Soc. Jour. 9:233, pl.8, fig.2

Body pale brown to yellowish; head very broad, flattened above, finely rugose, blackish around the ocelli, front margins black, ocelli yellow, head marked behind with three impressed reticulated spaces; palpi black; mandibles of male very long, blackish tubercles on inner edges, color same as head but darker near the tips; prothorax scarcely longer than broad, hardly dilated behind, brownish with front margin blackish, the hastate median mark behind, and raised spaces each side of about the same shade as the prothorax; mesothorax and metathorax nearly equal in width to each other and to the prothorax or slightly narrower than the hind margin of it; legs pale brown, tarsi, knees, and parts of the tibiae dark fuscous; antennae as long as the body or longer, thick, brown, sutures black, three to four terminal joints black, basal joints bulbous, joints beyond basal fourth with a short, straight, triangular tooth beneath; appendages of male very long, slightly pilose; superior pair nearly cylindric at base, tips dilated and truncated but suddenly bent downward and produced toward the body into a short process; inferior pair not half so long, cylindric, curved upward at the tips; wings cinereo-hyaline, front pair with white dots in the cells, stigmatic region dark, subcostal region often dark fuscous and with paler spaces, veins yellowish, cross veins mostly black except the middle part of many toward the center of C–Sc, cross veins between all the branches of radius about 17 or 18, medius with three branches, Cu_1 with four accessory veins; hind wings scarcely paler than the others, subcostal area clouded, some of the cross veins dark. Length of body without appendages about 45mm; alar expanse 120 to 135 mm.

San Antonio Tex.

5 **C. peruviana** n. sp.

Body brown; head brown, finely rugose behind; mandibles darker than the head; prothorax much longer than broad, the median hastate mark behind concolor, roughened areas along each side reaching the whole length; legs and feet of same shade as the head; antennae of female slender, brown, black toward the tips; those of male stout, very long, slightly toothed, minute papillae all over, bright yellow, bases yellow, outer end black; wings subcinereo-hyaline, cross veins mostly darkened, a few of those in costal region lighter in the middle; white and dusky clouds from stigma across to middle of Cu_1, no white dots in the costal cells and none at all on the hind pair of wings; in front pair, cross veins between all the branches of radius, about 28 to 30, media with four branches. Cu_1 with five accessory veins. Length to tip of wings 80 to 85 mm; alar expanse about 130mm.

Types in Museum of Comparative Zoology; female from "head waters of Rio Rimac, Peru, in the Cordilleras"; male labeled "Guatamala purchase."

6 **C. lutea** Hagen

1861 Corydalis lutea Hagen, Synopsis Neur. N. Am. p.193

1861 Corydalis vetula Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)

1861 Corydalis armigera Hagen, Synopsis Neur. N. Am. p. 321 (*nomen nudum*)

General color luteous; head large, broad, ferruginous, the sides convex, marked behind with obsolete luteous spots; prothorax much narrower than head, longer than broad; sides of middle obsoletely impressed; concolor or luteous spots behind and at the sides; legs lurid, base of tibiae and some tarsal segments nigro-fuscous; antennae slender, light yellow to brown, dark at outer end; superior male appendages cylindric, long, oblique, truncated at apex; inferior ones recurved at the apex, clavate; wings subcinereo to luteo hyaline; cross veins dark except the middle part of those of costal region; veins luteous, partly fuscous; a few white dots, usually only one to a cell; front pair with cross veins between all branches of radius about 25, media with three branches, Cu_1 with four to five branches. Length to tip of wings 55 to 85 mm; alar expanse 110 to 140 mm.

Vera Cruz, Mexico, Brazil, Cordova, Spain.

7 C. batesii McLachlan

1868 Corydalis batesii McLachlan, Linn. Soc. Jour. 9:232, pl.8, fig.1

Color of body brown, or dusky on the abdomen; head above and beneath dark brown; mandibles of female black at tips; palpi black; head marked behind with five punctures, front margin yellow; ocelli yellow; eyes dark olivaceous; prothorax longer than broad, scarcely dilated behind, sides nearly parallel, very convex above, smooth, dull brown, with three short impressed concolor spaces behind; mesothorax and metathorax scarcely broader than the prothorax, pale brown; legs finely pilose, fuscous, paler beneath, all tarsi and the apical part of the tibiae yellowish, specially behind; antennae yellow with black tips, very slender, not toothed, not over two thirds the length of the body; wings long and narrow, front pair ashy, dusky area beyond the middle, many blackish blotches in front portion, one at stigmatic region, several in subcostal region, and others back of the radius, white dots in the cells, several angles of the veins black, cross veins mostly black except the middle parts of those in the basal half of costal region; hind pair broader and paler than the other, some dusky clouds and black veins and cross veins near front margin.

Ega, Brazil. Type, a female, in McLachlan's collection.

8 C. nubila Erichson

1848 Corydalis nubila Erichson, Schomburgk, Reise Guiana. 3:583
1861 Corydalis nubila Hagen, Synopsis Neur. N. Am. p.321

Body dark brown to brownish yellow; head broader than the prothorax, brown on the sides back of the eyes, roughened behind; prothorax rather narrow, dull brown, concolor; legs and feet light brown; antennae black, slender, slightly toothed as in C. crassicornis, a little longer than head and thorax in the female; superior pair of male appendages bent downward; front wings subcinereo-hyaline with brown shade above anal area, a dark oval spot about the first branching of medius and white dots near by, a white triangular cloud at stigma reaching nearly through cell R_1, no white dots in costal region, cross veins mostly dark; medius with four branches, cross veins between all the branches of radius, about 20 to 22; hind wings more yellowish, and no white dots in the cells. Length to tip of wings about 60mm; alar expanse 75 to 100 mm.

British Guiana, Venezuela. One female from the latter country in the Harvard museum.

9 C. armata n. sp.

1861 Corydalis armata Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*)
1842 Corydalis cornuta Rambur, Hist. Nat. Neur. p.440
1853 Corydalis cornuta Walker, Cat. Brit. Mus. Neur. p.208

Body brown; head brown, finely rugose; mandibles brown, with three teeth besides the apex in females; thorax longer than broad, brown all over, the median hastate mark behind concolor roughened areas along each side reaching the whole length of the segment; legs and feet lighter than the head in color; antennae slender, brown, black toward the outer end; wings subcinereo-hyaline, veins fuscous, cross veins mostly darkened, those of costal region mostly light in center; front pair dusky in stigmatic region, and sometimes near the first branching of radius, cells of costal region partly with one white spot, never two, other cells of front pair and in apical region of hind pair with white dots; cross veins between all branches of radius in front pair, about 30 to 31, media with four branches, Cu_1 with five or six accessory veins. Length to tip of wings 75 to 85 mm; alar expanse 110 to 140 mm.

Republic of Colombia, Venezuela, Chapada, Brazil, "S. Catharina, Theresopolis, Fruhstorfer, 1887." Several specimens in the Museum of Comparative Zoology.

C. ancilla Hagen, Synopsis Neur. N. Am. p.321 (*nomen nudum*), must still remain undescribed, as the only known specimen is in the Hagen collection and is too much injured for use. This specimen is from Paraguay, and it is hoped that other specimens may be discovered there.

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EXPLANATION OF PLATES

PLATE 1

Renwick lagoon at the head of Cayuga lake, Ithaca N. Y. Characteristic shore vegetation. Photo by J. H. Comstock

PLATE 2

Renwick lagoon, open water. Photo by J. H. Comstock

PLATE 3

Upper reaches of a bayou leading from Renwick lagoon across "the flats." Photo by J. H. Comstock

PLATE 4

Two views along Fall creek, near Ithaca N. Y. (1) Forest lake, looking toward the fall where the creek enters. (2) In the bottom of the gorge; one of the many small cascades; Simulium territory. Photos by H. N. Howland

PLATE 5

Aeschna constricta Say

1 Male imago. Photo from life by J. G. Needham

2 The nymph approaching a back swimmer. Drawing by Miss Anthony

PLATE 6

Unknown caddis fly larva, eaten by Bone pond brook trout

1 Head of larva. 2 End of abdomen. 3 Case. 4, 5 and 6 Legs of one side.

PLATE 7

Callibaetis skokiana Ndm.

1 Imago

2 Nymph

Photo from life by J. G. Needham, colored by Miss Anthony, after life

PLATE 8

Epiphragma fascipennis Loew. Drawing by Miss Anthony

PLATE 9

Epiphragma fascipennis, larva and pupa. Drawings by Miss Anthony

1 Larva, lateral view, anal gills almost withdrawn into the body

2 Respiratory disk on end of abdomen of larva

3 Pupa, ventral view

PLATE 10

Diptera

Immature stages

1 Larva of an unknown Leptid from rapids

2 One of its paired bifurcated abdominal prolegs, showing grappling hooklets protruded

3 Pupa of Tipula flavicans Loew

4 Larva of an unknown Tipulid from springs

5 End of abdomen of same from above

PLATE 11

Calopteryx maculata Beauv. Male and female. Photo from life by J. G. Needham

PLATE 12

Hetaerina americana, executed from nature, under the author's direction, by L. H. Joutel

1 and 2 Males
3 Female
4 and 5 Cast nymph skins
6 and 7 Nymphs in the rapids

PLATE 13

Chromagrion conditum and Argia violacea

1 and 2 Resting and flying attitudes of C. conditum. 3 Nymph of same
4 Argia violacea male. 5 Nymph of same

PLATE 14

Labia of Zygopterous nymphs

a Labium of Calopteryx maculata. *b* Labium of Hetaerina americana. *c* Labium of Lestes rectangularis, right lateral lobe omitted. *d* Left lateral lobe of same, more enlarged. *e* Labium of Argia sp.?, right lateral lobe omitted, portion of spinulose edge of median lobe shown highly magnified above. *f* Right lateral lobe of same more enlarged. *g* Right lateral lobe of labium of Chromagrion conditum. *h* Right lateral lobe of labium of Amphiagrion saucium. *i* Left lateral lobe of labium of Nehallennia irene. *j* Right lateral lobe of labium of Anomalagrion hastatum.

PLATE 15

Median caudal gills of Zygopterous nymphs

a Argia tibialis. *b* Chromagrion conditum. *c* Amphiagrion saucium. *d* Nehallennia irene. *e* Anomalagrion hastatum.

PLATE 16

Zygoptera

1 Lestes uncata Kirby. Photo from life by J. G. Needham
2 Enallagma exsulans Hagen. Photo from life by J. G. Needham
3 Drawing of nymph of Enallagma carunculatum Morse
4 Immature nymph of Enallagma antennatum Say. Photo from alcoholic specimen by J. G. Needham
5 Ischnura verticalis Say. Photo from alcoholic specimen

PLATE 17

Agrioninae

Drawings by Mrs J. G. Needham
1 Argia apicalis Say
2 Enallagma signatum Hagen
3 Enallagma carunculatum Morse
4 (male) and 5 (female) Ischnura verticalis Say

PLATE 18

Zygoptera

Photos from alcoholic specimens by Lee C. Stiles

1 and 2 Amphiagrion saucium Burm. male and female
3 and 4 Nehallennia irene Hagen, male and female
5 and 6 Anomalagrion hastatum Say, male and female
7 Nymph of A. saucium
8 Wing of Lestes rectangularis Say

PLATE 19

Enallagma

Male abdominal appendages of New York species

a E. annexum. *b* E. hageni. *c* E. geminatum. *d* E. piscinarium. *e* E. divagans. *f* E. exsulans. *g* E. ebrium. *h* E. carunculatum. *i* E. civile. *j* E. aspersum. *k* E. traviatum. *l* E. antennatum. *m* E. signatum. *n* E. pollutum.

List of abbreviations for plates 20-31

a	Cocoons from which adults have emerged
al	Alimentary canal
as	Anterior sclerite
ast	Anterior sternal setae
at	Anterior tergal setae
bh	Breathing holes
c	Cuticle
ccp	Cavity surrounding the cuticular pocket
cp	Cuticular pocket
cs	Caudal spine
css	Holes made by the caudal spines
d	Dorsum
da	Dorsal apodeme
dc	Dorsal cavity
ds	Distal setae of the labrum
e	Holes eaten in the stems by larvae
ec	Empty cavities
ex	Location supposed opening in the paired dorsal cavities
h	Hypodermis
hcp	Hypodermis of the cuticular pocket
is	Infraspiracular setae
l	Lamellae
lg	Leg
ln	Lumen
lr	Lumen respiratory system
ls	Lateral setae
m	Muscle
md	Median setae of the labrum
mg	Marginal setae of the labrum
ms	Mesothorax
mt	Metathorax
o	Cocoons

os	Opening of the spiracle
p	Pleura
pc	Peripheral layer of chitin of the caudal spines
pdc	Paired dorsal cavities
pe	Peritreme
pf	Prothoracic filaments
pr	Prothorax
ps	Pedal setae
pst	Posterior sternal setae
pt	Posterior tergal setae
pvc	Paired ventral cavities
px	Proximal setae of the labrum
r	Denuded roots
rec	Rectum
s	Spiracle
su	Sensory spots
ss	Supraspiracular setae
st	Sternal setae
t	Tracheal taenidia
tr	Trachea
ttr	Transverse tracheal trunk
v	Venter
vc	Ventral cavity
vh	Vacuolated hypodermal cells
vv	Ventral border paired ventral cavities
w	Cuticular wedge paired ventral cavities
x	Leaf stalks
y	Scars of shed leaf stalks
z	Larvae

PLATE 20

View near the outlet of the Renwick lagoon, looking southeast. Photo by J. H. Comstock

PLATE 21

1 Portion of leaf of Nymphaea advena, showing eggs of Donacia palmata. Photo by J. G. Needham
2 Portion of leaf of a sedge, showing the eggs of Donacia porosicollis
3 Eggs of Donacia cincticornis
4 A single egg mass of Donacia palmata

PLATE 22

Underground stem of Nymphaea advena, showing larvae and cocoons of Donacia palmata. Photo by J. O. Martin

PLATE 23

Plant of Sparganium androcladium. Photo by J. G. Needham

a Summit of the plant with beetle on the leaf. *b* Roots as withdrawn from the water, showing cocoons of Donacia emarginata near the base of the leaves

PLATE 24

Sections of the stem of Sagittaria

1 Cross section. 2 Longitudinal section, both showing intercellular spaces and arrangement of tissues

3, 4 Eggs of Donacia porosicollis

PLATE 25

Donacia

Anatomic details of the larvae. Enlarged

DONACIA CINCTICORNIS

1 Mandibles. 2 Antennae. 3 Leg. 4 Maxilla. 5 Labium. 6 Labrum

DONACIA PALMATA

7 Maxilla. 8 Antenna. 9 Labrum. 10 Eyes. 11 Mandibles. 12 Leg

DONACIA SUBTILIS

13 Eye. 14 Leg. 15 Mandibles. 16 Maxilla. 17 Labrum. 18 Labium. 19 Antenna

PLATE 26

Donacia

Anatomic details of the larvae. Enlarged

DONACIA POROSICOLLIS

1 Mandibles. 2 Maxilla. 3 Labrum. 4 Labium. 5 Leg. 6 Eyes. 7 Antenna

DONACIA AEQUALIS

8 Mandibles. 9 Maxilla. 10 Antenna. 11 Labrum. 12 Leg

DONACIA EMARGINATA

13 Labrum. 14 Antenna. 15 Labium. 16 Maxilla. 17 Leg. 18 Mandibles

PLATE 27

Haemonia, Galerucella and Donacia palmata

Anatomic details of the larvae

HAEMONIA NIGRICORNIS

1 Mandibles. 2 Labrum. 3 Labium. 4 Leg. 5 Eyes. 6 Maxilla. 7 Antenna

GALERUCELLA NYMPHAEAE

8 Mandibles. 9 Labrum. 10 Leg. 11 Labium. 12 Maxilla

DONACIA PALMATA

13 Larva just emerged from the egg. 14 Dorsal apodeme. 15 Longitudinal section of a trachea. 16 Surface section of trachea showing taenidia. 17 Lateral view of apex of abdomen of mature larva. 18 Portion of a stem of Nymphaea advena with a mature larva feeding with its head and thorax buried in the tissues of the plant. 19 Dorsal aspect of the four apical abdominal segments of a mature larva

PLATE 28

Donacia palmata

Anatomic details of the caudal abdominal spiracle. Enlarged

1 Portion of a stem of Nymphaea advena with a mature larva attached to it by its caudal spines, in the act of respiring

2 Lateral view of a caudal spine and its internal attachment

3 Apex of a caudal spine still more enlarged

4 A transection of a caudal spine at the level *d–e* of figure 2

5 A transection of a caudal spine at the level *f–g* of figure 2

6 A transection near the base of the caudal spines
7 A transection through the cephalis end of a cuticular pocket
8 A sagittal section through the base of a caudal spine and its cuticular pocket laterad of the spiracular opening
9 A transection of a cuticular pocket taken at about the level *n–o* of figure 8
10 A transection through the spiracular opening
11 A transection taken caudad of the spiracular opening
12 A transection of a cuticular pocket, showing its connection with a trachea
13 A transection of a cuticular pocket taken cephalad of the spiracular opening
14 A section through the transverse connection of the tracheal trunks and the dorsal apodeme
15 A portion of the hypodermis and some cuticular plates greatly enlarged
16 Some cuticular plates still more enlarged
17 A sagittal section through the apex of the abdomen of a mature larva mesad of a spiracular opening.

PLATE 29

Donacia

Setal arrangement of the larvae
1 Donacia cincticornis
2 Donacia palmata
3 Donacia subtilis
4 Donacia porosicollis

PLATE 30

Donacia and Haemonia

Setal arrangement of the larvae
1 Donacia aequalis
2 Donacia emarginata
3 Haemonia nigricornis
Anatomic details of Donacia palmata
4 Lateral view of the abdomen of the adult female
5 Dorsal view of the same
6 Portion of a rhizome of Nymphaea advena, showing the attachment of the cocoon

PLATE 31

The food plant, Brasenia peltata, and transformations of Galerucella nymphaeae. Drawn by Miss Anthony

PLATE 32

Simulium territory

A little fall in the bottom of Cascadilla gorge.

PLATE 33

Simulium meridionale

1 Mandible of larva. x110
2 Maxilla of larva. x110
3 Hypopharynx of larva. x110
4 Labium of larva. x190
5 Respiratory filaments of pupa. x40

Simulium pecuarum

6 Mandible of larva. x110
7 Hypopharynx of larva. x110
8 Labium of larva. x190
9 Maxilla of larva. x110
10 Respiratory filaments of pupa. No scale
11 Labrum of larva. x110

PLATE 34

Simulium hirtipes

1 Wing of male. x15. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal
2 Palpus of adult. Female. x40
3 Maxilla of larva. x110
4 Labium of larva. x110
5 Antenna of larva. x110
6 Mandible of larva. x110
7 Ventral view of head of larva. No scale. *lr* Labrum. *m* Mandible. *x* Maxilla. *l* Labium. *f* Fan
8 One ray of fan of larva. No scale
9 Larva. x6
10 Pupa. x6
11 Ventral view of caudal disk. x6
12 One of the radial rows of hooks of caudal disk. No scale
13 Pupal respiratory filaments. No scale

PLATE 35

Simulium vittatum

1 Respiratory filaments of pupa. x40
2 Labium of larva. x190
3 Mandible of larva. x110

Simulium sp.

From California, Santa Cruz mountains
4 Respiratory filaments of pupa. No scale
5 Pupal case. No scale
6 Mandible of larva. x110
7 Labium of larva. x190

From Leland Stanford jr University campus
8 Labium of larva. x190

From Las Vegas N. M.
9 Antenna. x190
10 Labium. x110

PLATE 36

Simulium pictipes

1 Mandible of larva. x110
2 Maxilla of larva. x110
3 Labium of larva. x110
4 Hypopharynx of larva. x110
5 Labrum of larva. x110

6 Cross section of hypopharynx. x110
7 Wing of male. x15
8 Thoracic respiratory filaments of pupa. x15

PLATE 37

Simulium venustum and varieties

1 Maxilla of larva. x110
2 Hypopharynx of larva, var. piscicidium. x110
3 Labrum of larva, venustum. x110
4 Respiratory filaments of pupa. x40
5 Labium of larva, var. piscicidium. x190
6 Labium of larva, venustum. x190
7 Respiratory filaments of pupa, var. piscicidium. x110
8 Wing of imago, var. a
9 Caudal appendages (blood gills) of larva, var. a. x110
10 Hypopharynx of larva, var. a. x110
11 Thoracic respiratory filaments of pupa, var. a. x110
12 Labrum of larva, var. a. x110
13 Mandible of larva, var. a. x110
14 Labium of larva, var. a. x190

PLATE 38

Legs. x50; claws. x190
1 S. venustum (var. piscicidium). Hind tarsus of male
2 S. venustum (var. piscicidium). Middle tarsus of male
3 S. venustum (var. piscicidium). Fore tarsus of male
4 S. venustum (var. a) Fore tarsus of female
5 S. venustum (var. a) Middle tarsus of female
6 S. venustum (var. a) Hind metatarsus of male
7 S. pecuarum. Hind metatarsus of female
8 S. pictipes. Hind metatarsus of male
9 S. vittatum. Hind metatarsus of female
10 S. hirtipes. Hind metatarsus of female
11 S. hirtipes. Hind metatarsus of male
12 S. meridionale. Male and female metatarsus
13 S. bracteatum. Female metatarsus
14 S. pecuarum. Claw of female
15 S. bracteatum. Claw of female
16 S. meridionale. Claw of female
17 S. pictipes. Male
18 S. meridionale. Male
19 S. venustum, var. piscicidium. Female
20 S. pictipes. Female
21 S. ochraceum. Hind metatarsus of female

PLATE 39

Corethra plumicornis

1 Larva of C. plumicornis. x12
2 Pupa of same. x12
2*a* Breathing tube of pupa. x110

3 Ventral view of head. x40. *e* Labium. *x* Maxillae

4 Lateral view of head, larva. *a* Antennae. *b* Filaments of third metamere of Meinert. *c* Leaflike appendages. *l* Labrum. *f* Fans. *m* Mandibles. *x* Maxilla

5 Swimming paddles of pupa. x15

6 Anal segment of larva. x40

7 Head of female. x15

8 Genitalia of male. x40

9 Wing of female. x15. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal

10 Wing of male. x15

11 Wing of C. albipes n. sp. x15

PLATE 40

Corethrella brakeleyi Coquillett

1 Full grown larva, dorsal view. x25. *a* Antenna. *b* Lateral sclerite of the head showing the spines. *d* Dorsal sclerite of the head

2 Ventral view of larval head. x25. *lr* Labrum. *md* Mandible. *b* Lateral sclerite of the head. *l* Labium

3 Antenna of larva. x110

4 Labrum of larva. x110

5 Larval mouth parts, ventral view. x110. *md* Mandibles. *mx* Maxilla: *i* Ventral lobe of the maxilla (perhaps cephalic prolongation of the head sclerite; *l* Labium

6 Dorsal view of left mandible of larva. x110

7 Fifth tarsal joint and claws of hind foot of adult male. x190

8 Antenna of adult male. x37½

9 Wing, denuded of hair. Female. x48

10 Last four abdominal segments of pupa. x37½

Culex sylvestris

11 Long claws of middle foot of male. x190

12 One of the claspers of the male. x48

PLATE 41

Pelorempis n. gen.

1 Larva, ventral view. Thorax and abdomen diagrammatic. x7

2 Head of same, dorsal view. x7

3 Mouth parts, ventral view. x40. *l* Labium. *x* Maxillae. *m* Mandible

4 Dorsal aspect of breathing apparatus on the eighth segment. x20. *s* Spiracle

5 Dorsal aspect of left mandible. x40

6 Dorsal aspect of labrum

7 Swimming paddles of the pupa. x7

8 Pupa. x7

9 A scale from upper surface of the labrum

10 Head of female

11 Lateral aspect of head. Female

12 Fore tarsal claw of female

13 Fore tarsus of female

14 Wing of female. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

PLATE 42

Anopheles punctipennis

1 Breathing apparatus on eighth segment, dorsal aspect. *s* Spiracle
2 Dorsal aspect of thorax and first abdominal segment. x15
3 Ventral aspect of head. x40. *l* Labium. *x* Maxillae. *p* Palpus. *m* Mandible
4 Lateral aspect of ninth abdominal segment
4*a* Palmate hairs on sides of the third to seventh abdominal segments
5 Wing of female
6 Dorsal aspect of the larval head. x40
7 Mandible of the larva. x110
8 Wing of Psorophora ciliata. Male
9 Wing of A. maculipennis female. *C* Costa. *Sc* Subcosta. ***R*** Radius. *M* Media. *Cu* Cubitus
10 Genitalia of male. x110
11 Breathing trumpet of pupa. x50

PLATE 43

Culex pipiens L.

1 Anal end of larva. x15
2 Head of larva. x15
3 Antenna of larva. x50
4 Dissection of ventral part of head, showing mouth parts. x50 *m* Mandible. *x* Maxilla. *l* Labium. *h* Hypopharynx
5 Ventral aspect of the upper lip. *lr* Labrum. *f* Fans. *e* Epipharynx. x50
6 Swimming paddles of pupa. x40
7 Pupa. x12
8 Fore tarsal claw of male. x110
9 Fore tarsal claw of female. x110
10 Wing of male. x15
11 Male genitalia. x50
12 Wing of female. x15. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

PLATE 44

Culex restuans

1 Labium of larva. x190
2 Mandible. x110. *s* Serrate spine
3 Dorsal aspect of head and thorax. x15
4 Antenna. x110
5 Dorsal aspect of hypopharynx. x400
6 Ventral aspect of epipharynx. x110
7 Caudal end of larva. x15
8 Dorsal aspect of labrum. *c* Clypeus
9 Wing of male
10 Wing of female
11 Breathing trumpet of pupa. x50
12 Palpus of adult male. x15
13 Palpus of adult female. x50

PLATE 45

Culex cantans Meigen

1 Ventral aspect of mandible. x110. Larva
2 Dorsal aspect of mandible. x110
3 Maxilla with palpus. Larva
4 Antenna of larva. x110
5 Serrate spine of the breathing tube, of larva
6 Caudal end of larva. x15
7 Dorsal aspect of thorax. Larva
8 Third, fourth and fifth fore tarsal joints of the male. x50
9 Wing of the male. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal vein
10 Long claw on middle foot of male

PLATE 46

Culex triseriatus Say

1 Antenna of the larva
2 Mandible, dorsal aspect. x110
3 Dorsal aspect of the head and thorax of larva. x15
4 Labium of larva. x190
5 Caudal end of larva, lateral aspect. x15
6 Hypopharynx of larva, conventionalized
7 Wing of female. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

Uranotaenia sapphirina O. S.

8 Dorsal aspect of larva. After Dyar
9 Caudal end of larva. After Dyar
10 Antenna of larva. After Dyar
11 Pupa. After Dyar
12 Male genitalia, lateral aspect. x110
13 Wing of female
14 Wing of male
15 Fourth and fifth tarsal joint of middle leg of the male

PLATE 47

Aedes smithii Coquillett

1 Antenna of larva. x110
2 Dissection of ventral part of the larval head, showing the mouth parts. x110. *m* Mandibles. *x* Maxillae. *l* Labium
3 Dorsal aspect of the larva. x18
4 Breathing trumpet of the pupa. x50
5 Swimming paddles of pupa. x15
6 Caudal end of the larva. x15

Diamesa waltlii Meigen

7 Antennae of the female. x50
8 Dorsal aspect of the male genitalia. x50
9 Wing of the female. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus
10 Male genitalia, ventral aspect. x50
11 Fore foot of the female

PLATE 48

Dixa modesta n. sp.

1 Ventral surface of larval head. x50. *l* Labrum. *a* Antenna. *mx* Maxilla with its palpus
2 Mandible of the larva. x190
3 Maxilla and its palpus, *p*. x115
4 Pupa. x15
5 Larva, ventral view. x15. *a* Ventral caudal lobe. *b* Ventral foot bristles. *c* Abdominal prolegs
6 Dorsal view of the dorsal head sclerite. x60
7 Dorsal view of the caudal appendages of the larva. x40. *p* "Triangular chitinized plate." *s* Spiracles
8 Wing of the imago. x15. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus. *A* Anal

Diamesa waltlii Meigen

9 Ventral view of the labrum of the larva. x190. *j* Jointed appendages. *e* Epipharynx
10 Ventral view of the labium of the larva. x190
11 Larval antenna. x190
12 Larval mandible. x190
13 Pupa. x12

PLATE 49

Chironomus sp.

1 Hypopharynx of the larva. x110
2 Antenna of the larva. x190
3 Ventral aspect of the upper lip, showing the epipharynx. x110
4 Head and thorax of larva, showing the thoracic proleg. x15
5 Ventral aspect of the head. *mn* Mandible. *mx* Maxillae. *l* Labium. x50
6 Mandible. x110
7 Caudal end of larva, with its anal prolegs. x15
8 Frontal aspect of the larval head. x50. *lr* Labrum. *m* Mandible. *a* Antenna. *l* Labium
9 Dorsal aspect of the larval maxilla. x190
10 Ventral aspect of seventh, eighth and ninth abdominal segments of pupa
11 Genitalia of the male. x50
12 Pupa

PLATE 50

Thalassomyia obscura n. sp.

1 Antenna of the larva. x190
2 Ventral aspect of the larval mandible. x190
3 Ventral aspect of the upper lip (labrum). x190. *e* Epipharynx
4 Dorsal aspect of the head. x50
5 Dorsal aspect of the larval hypopharynx. x190
6 Ventral aspect of the larval maxilla. x190
7 Armature of the thoracic prolegs. x400
8 Labium of the larva. x190
9 A claw from the anal prolegs of the larva. x400
10 Pupa
11 Armature of the abdominal segments of the pupa

12 Anal end of the larva with its prolegs. x50
13 Dorsal aspect of the male genitalia. x50
14 Foot of middle leg of female
15 Wing of male. *C* Costa. *Sc* Subcosta. *R* Radius. *M* Media. *Cu* Cubitus

PLATE 51

Sialis infumata

1 and 2 Eggs
3 Lateral filaments of the larva (photomicrographs).

PLATE 52

Corydalinae

Imagos and eggs
1 Chauliodes serricornis ♂. Natural size
2 Eggs of Chauliodes sp.? Enlarged
3 Neuromus pallidus ♂. One-sixth enlarged

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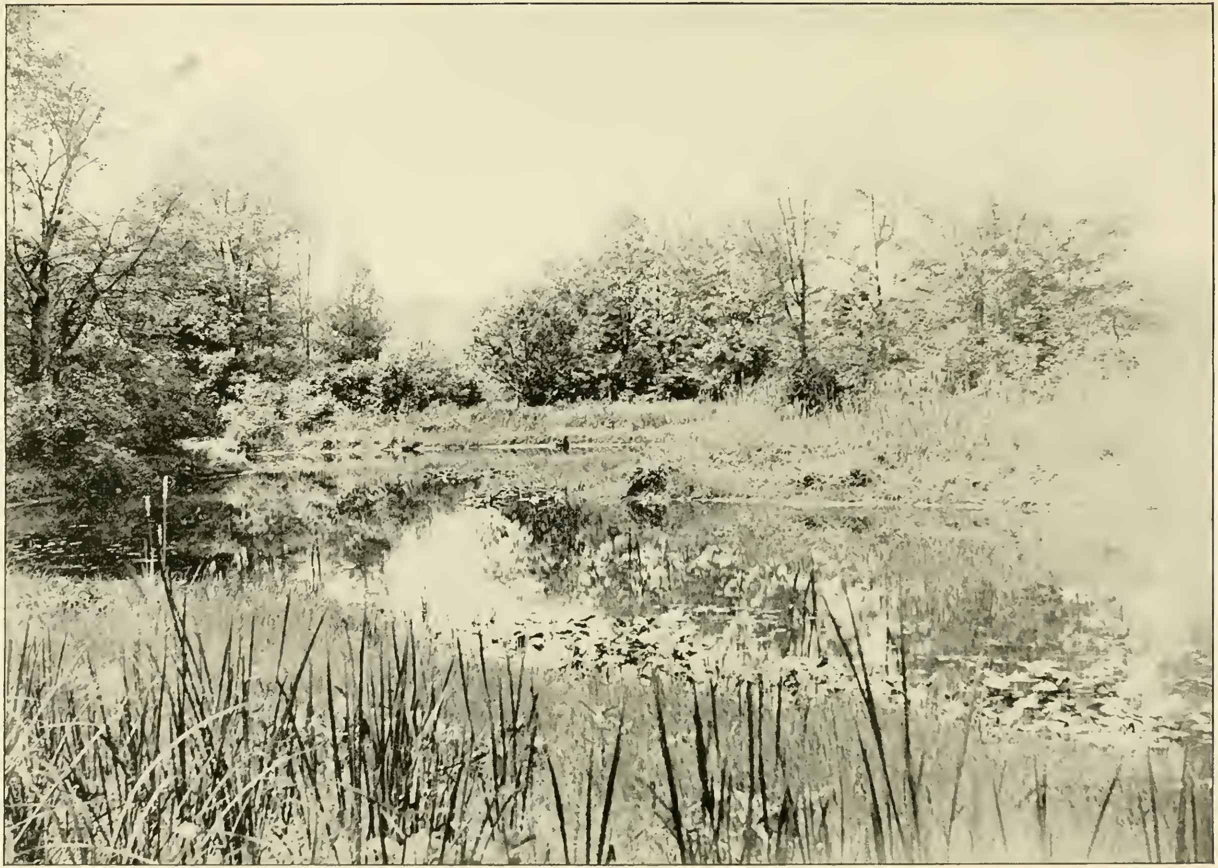
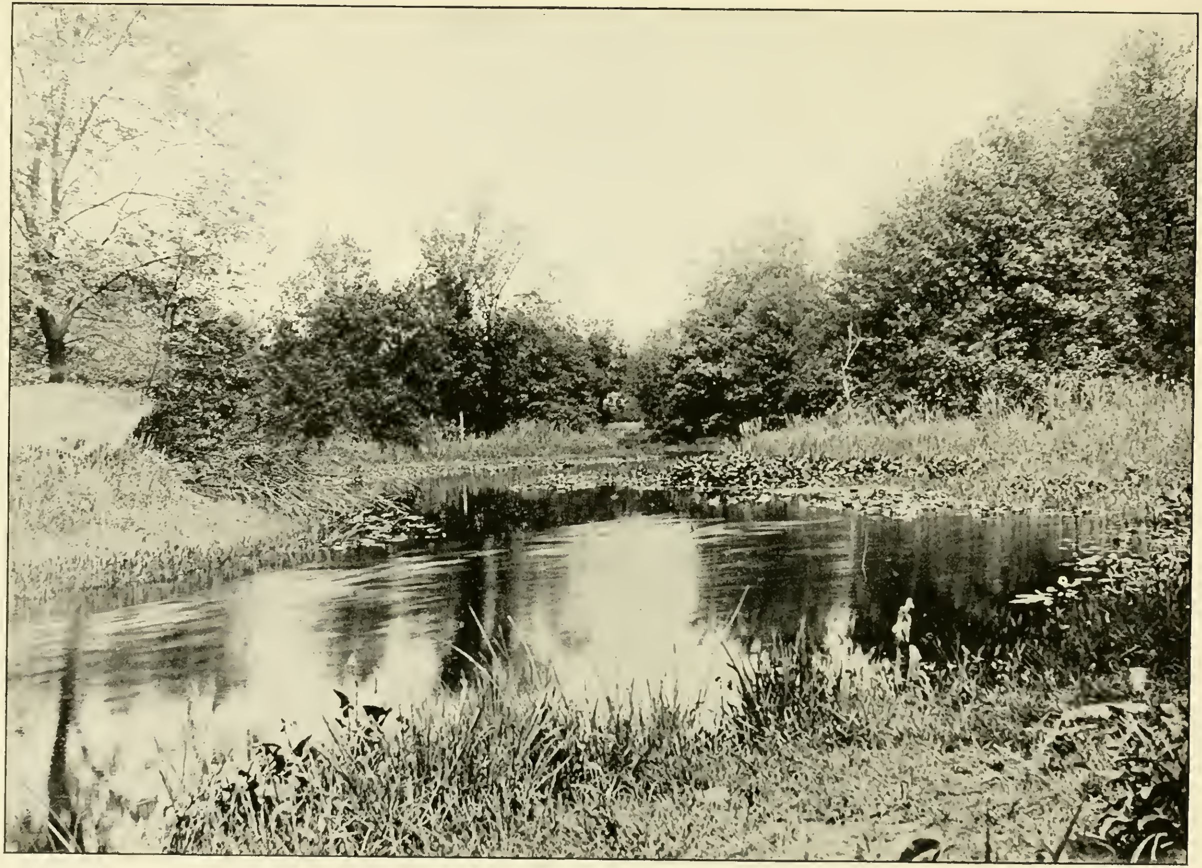
[1] Electros from Needham's *Out-door Studies* for plate 16, fig. 6, plate 17, fig. 3 and 5 and text figures 3 and 7 have been kindly loaned for use in this report by the American Book Co.

Plate 1



Renwick lagoon, shore vegetation

Plate 2

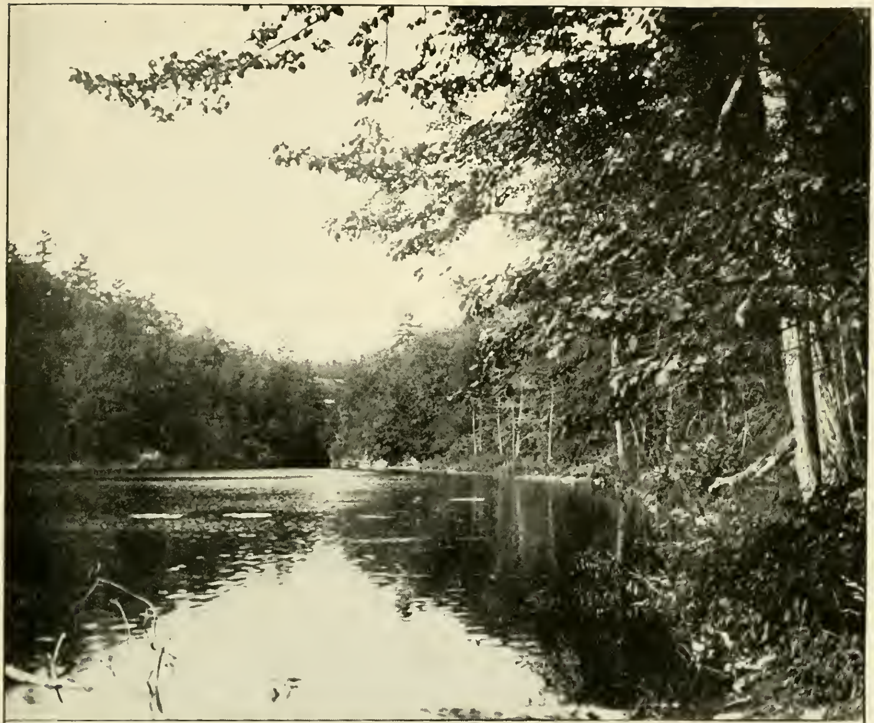


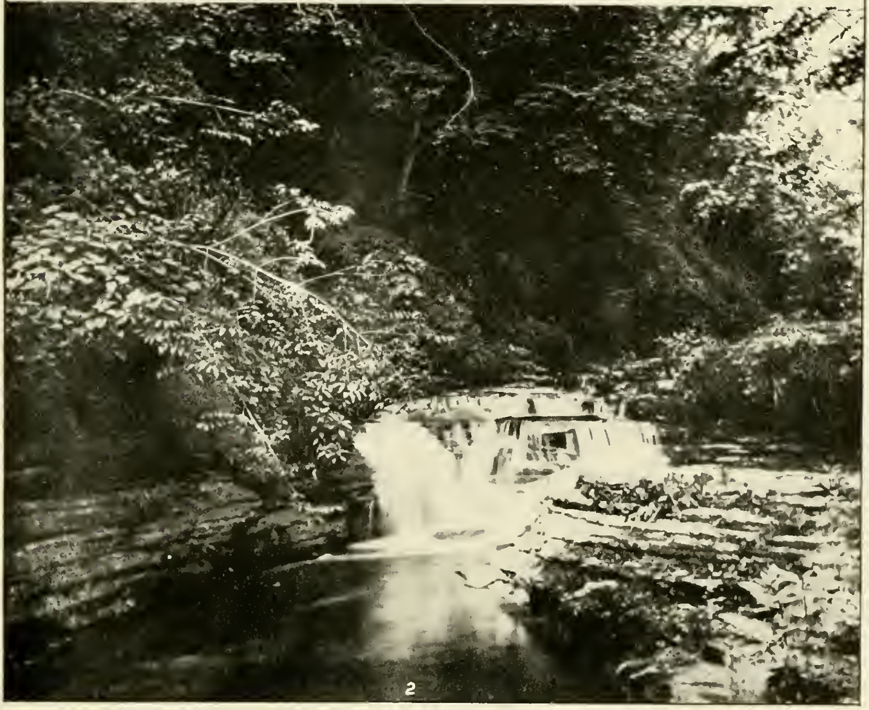
Renwick lagoon, open water

Plate 3

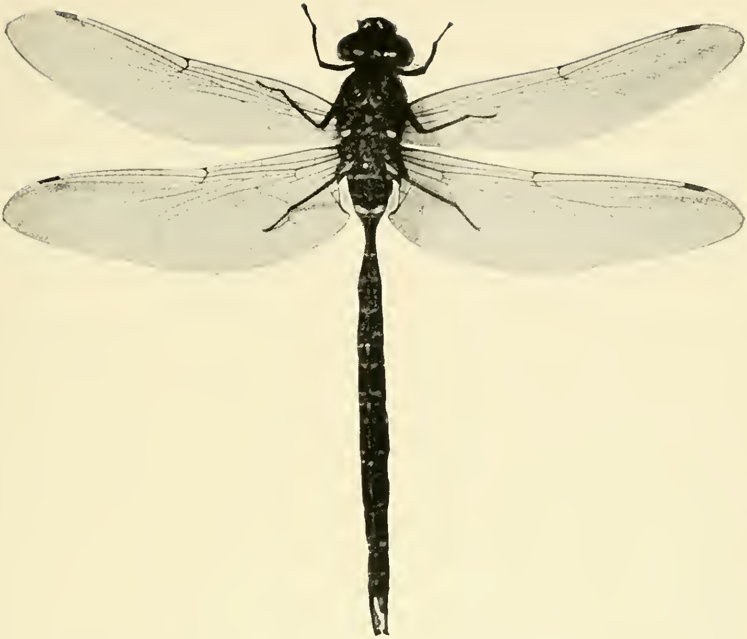
Bayou off Renwick lagoon

Plate 4





Views along Fall creek



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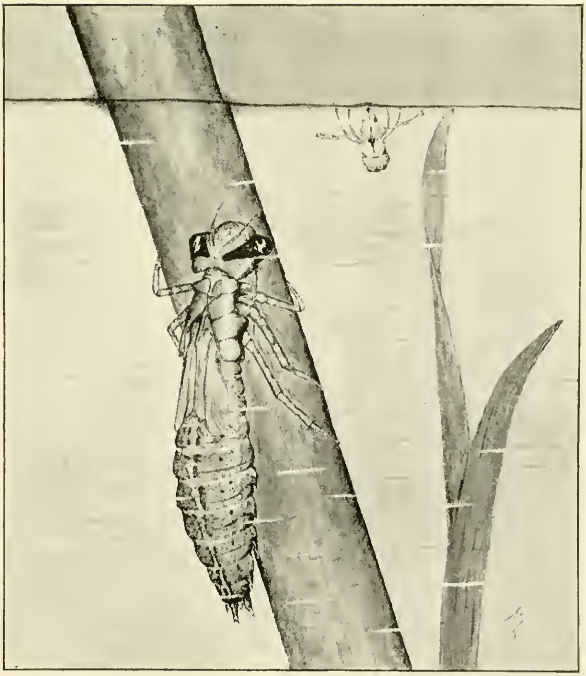

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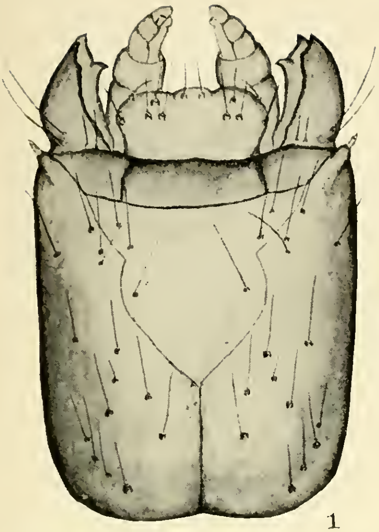
Dragon fly and larva (*Aeschna constricta*)

Plate 6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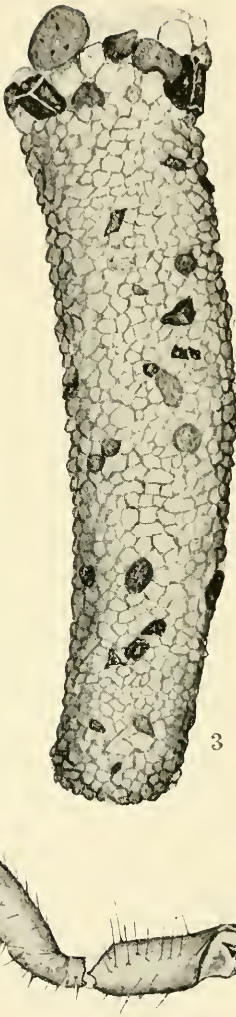
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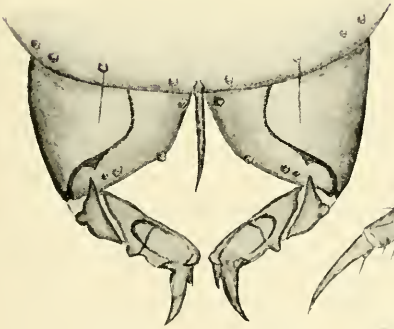
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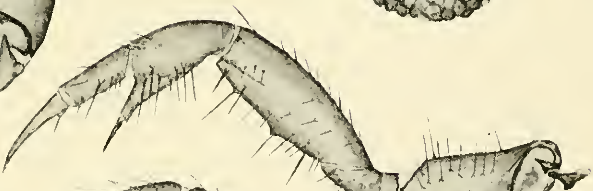
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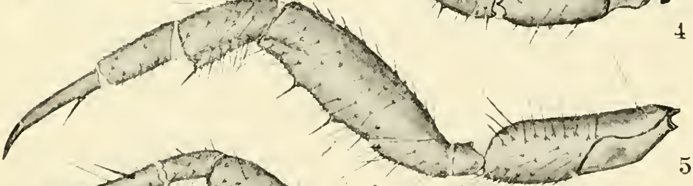
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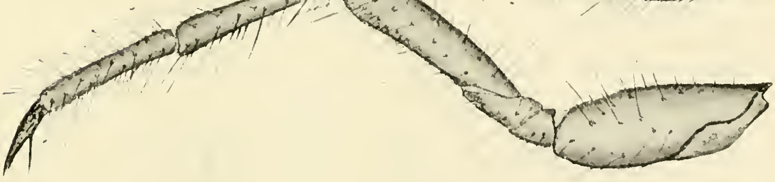
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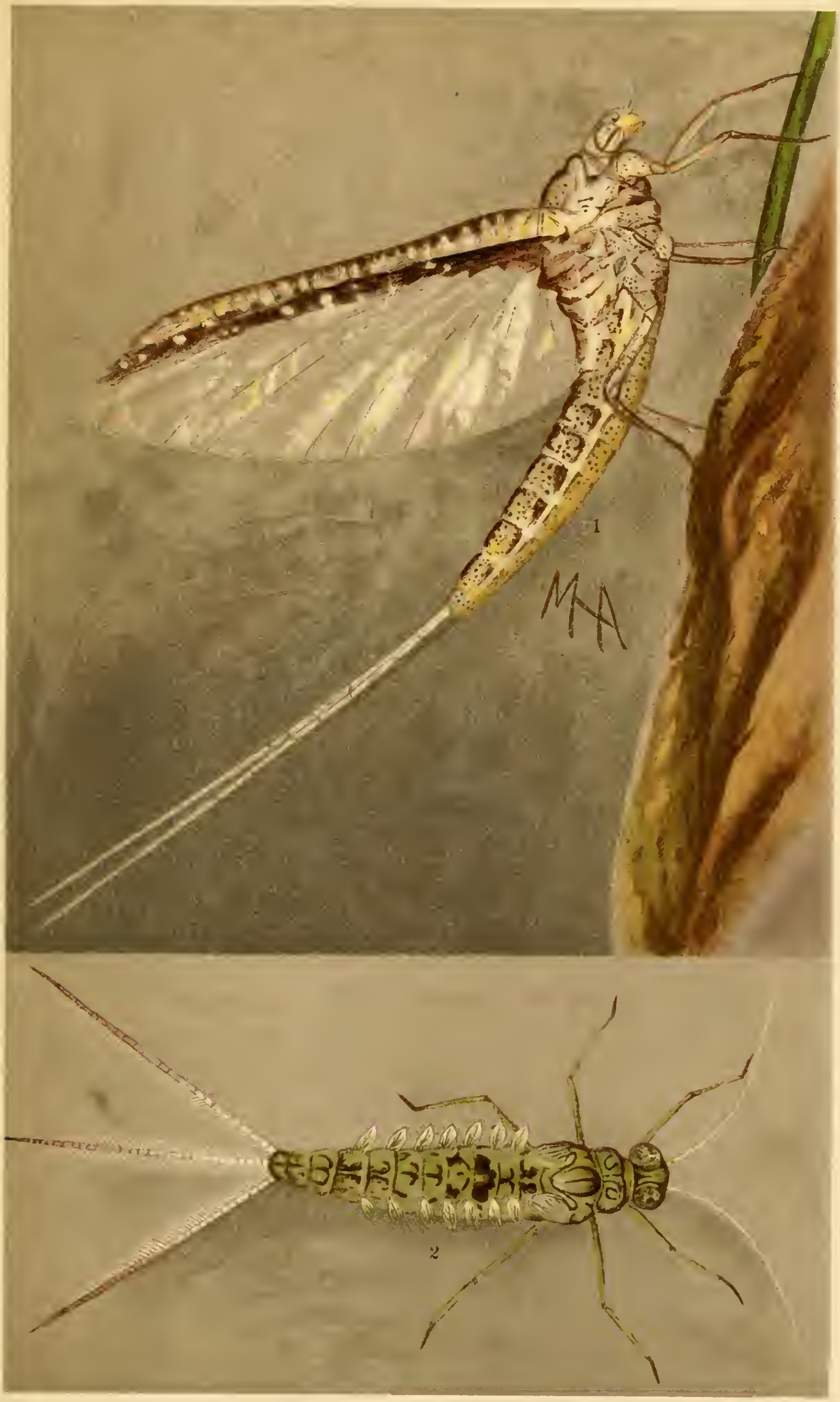
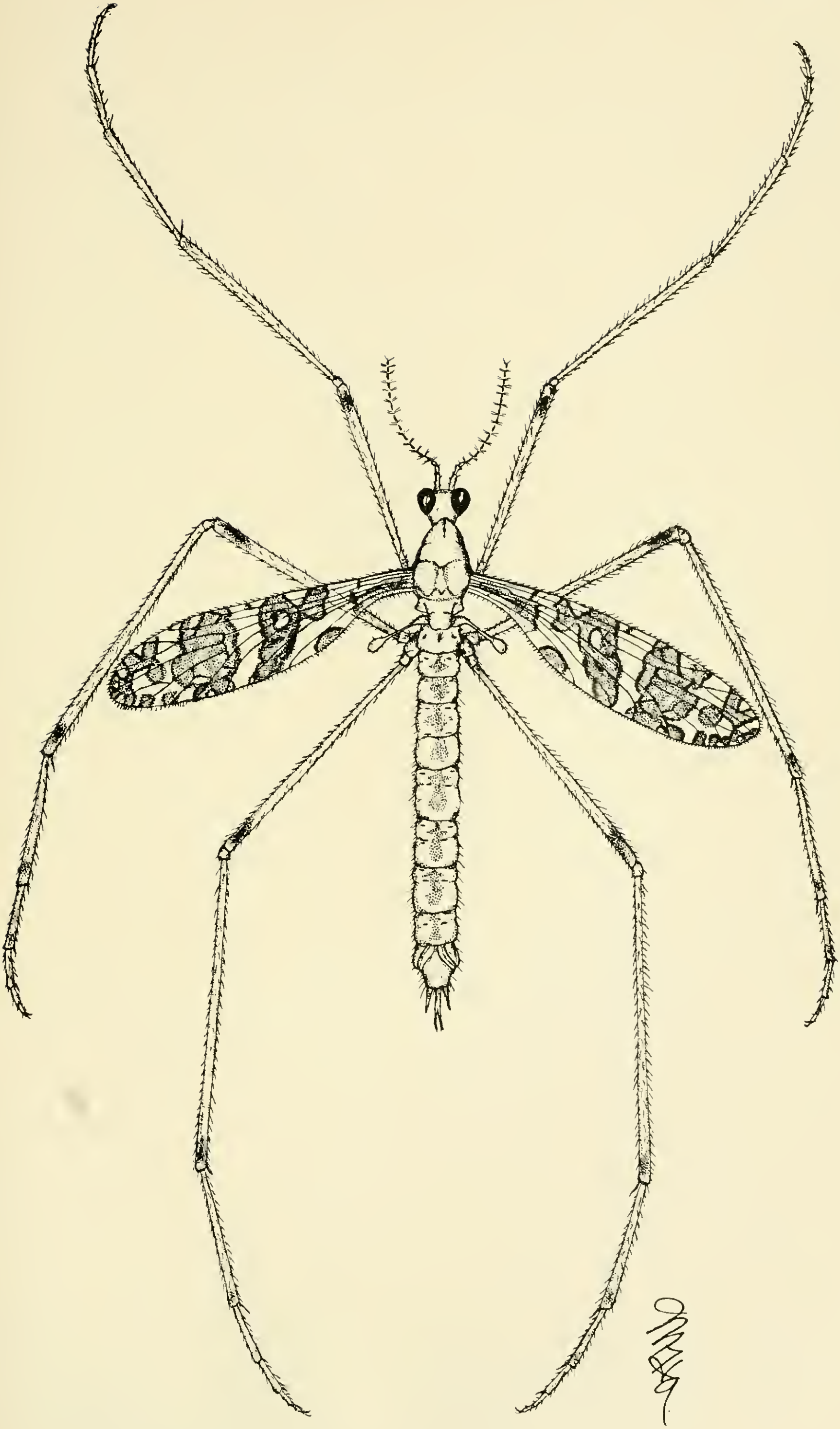
Caddis worm; brook trout food

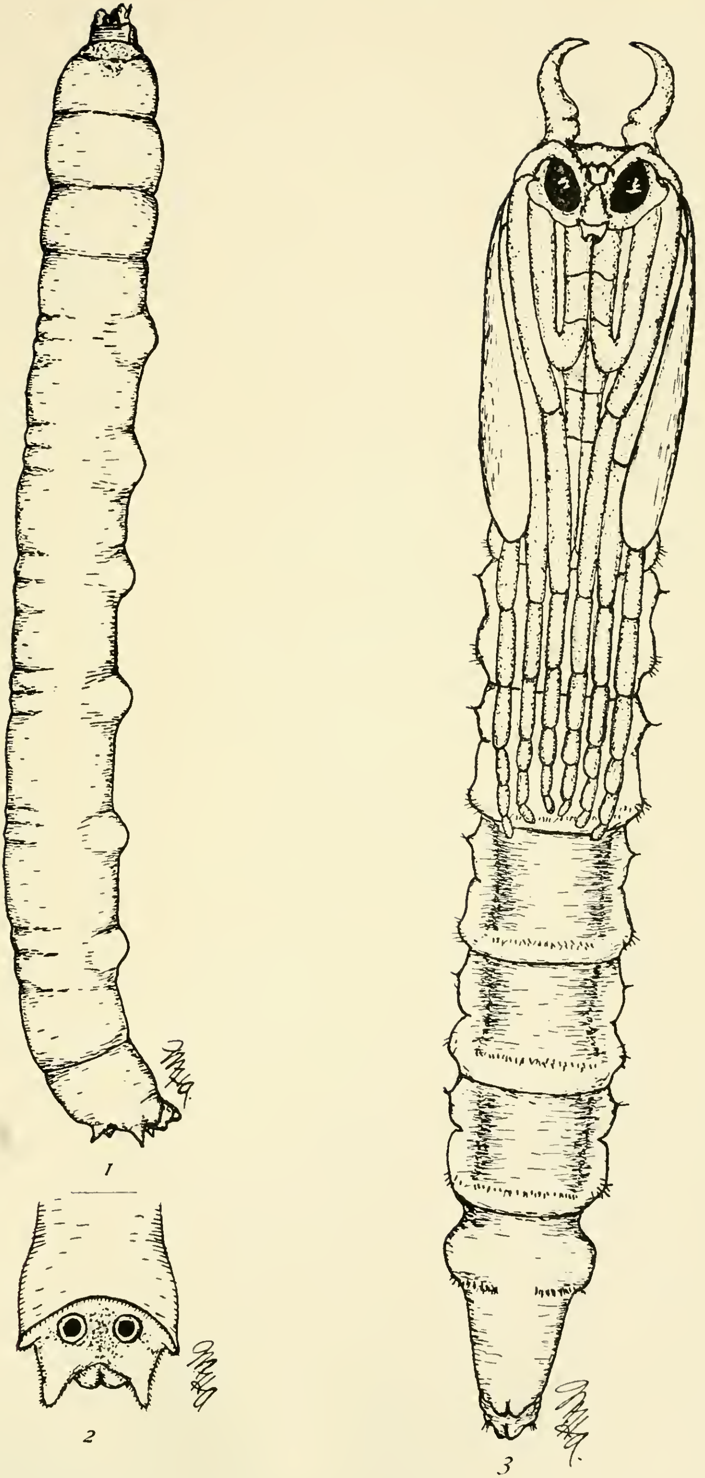


Callibaetis skokiana



Crane fly (*Epiphragma fascipennis*)

Plate 9



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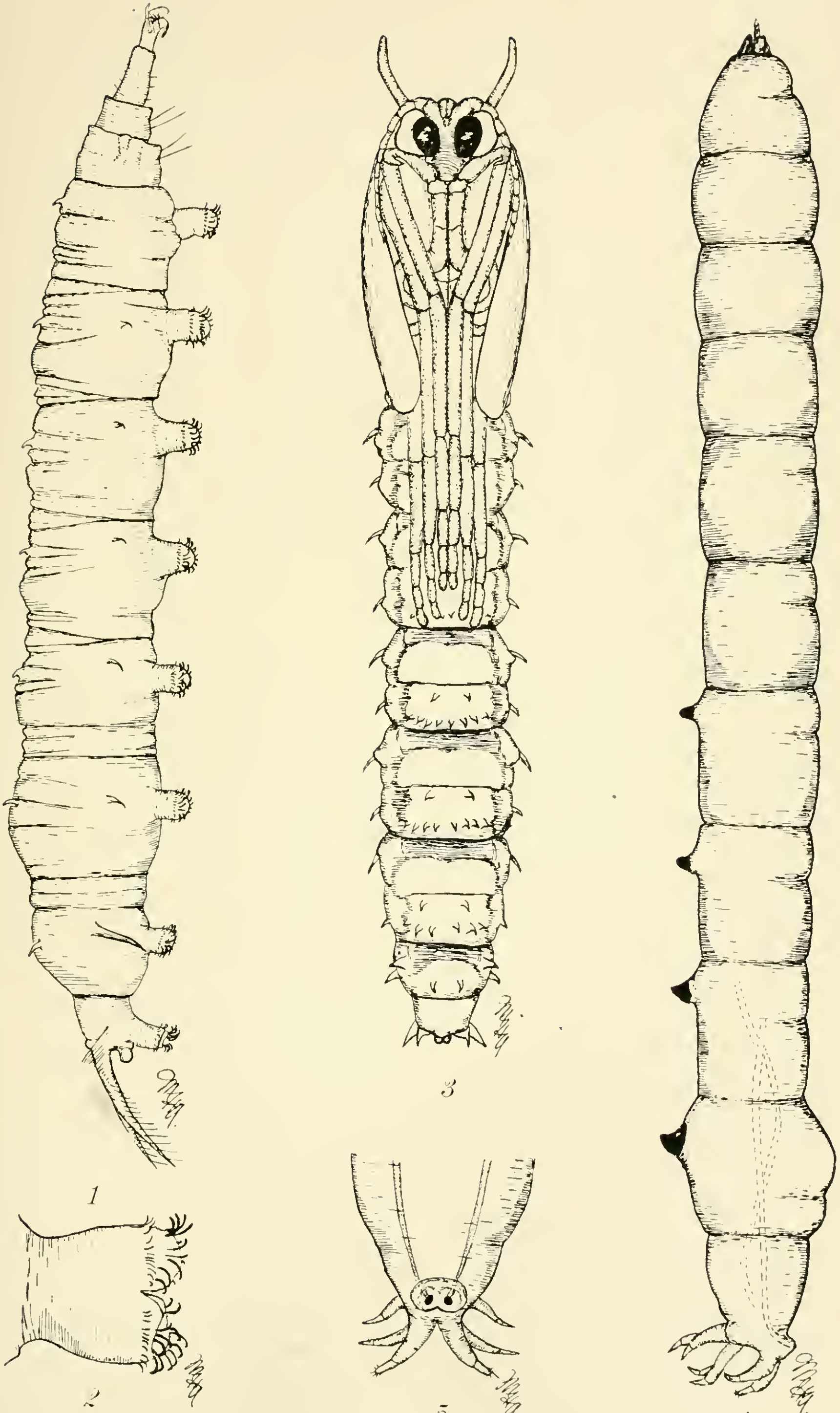
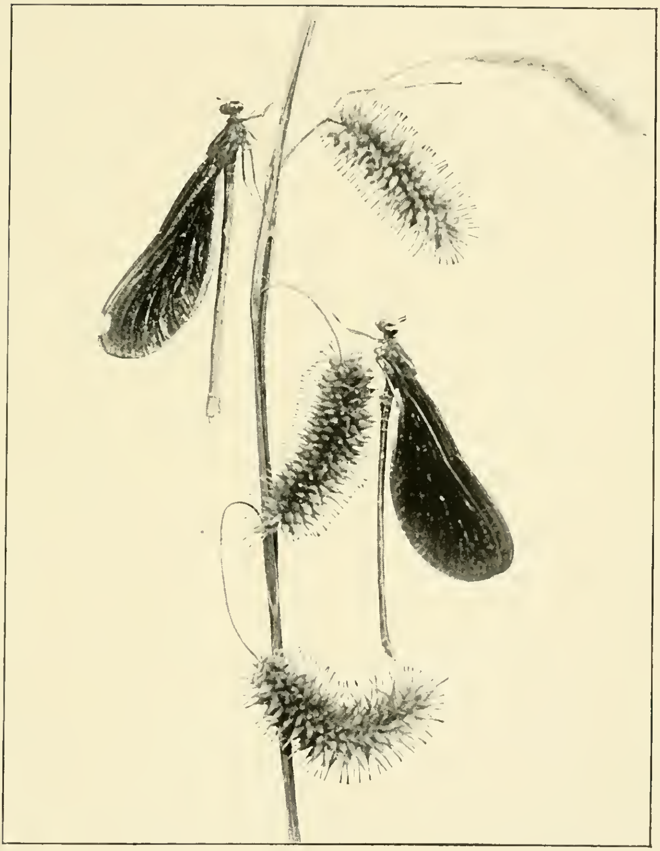
Larva and pupa of crane fly (Epiphragma fascipennis)

Plate 10

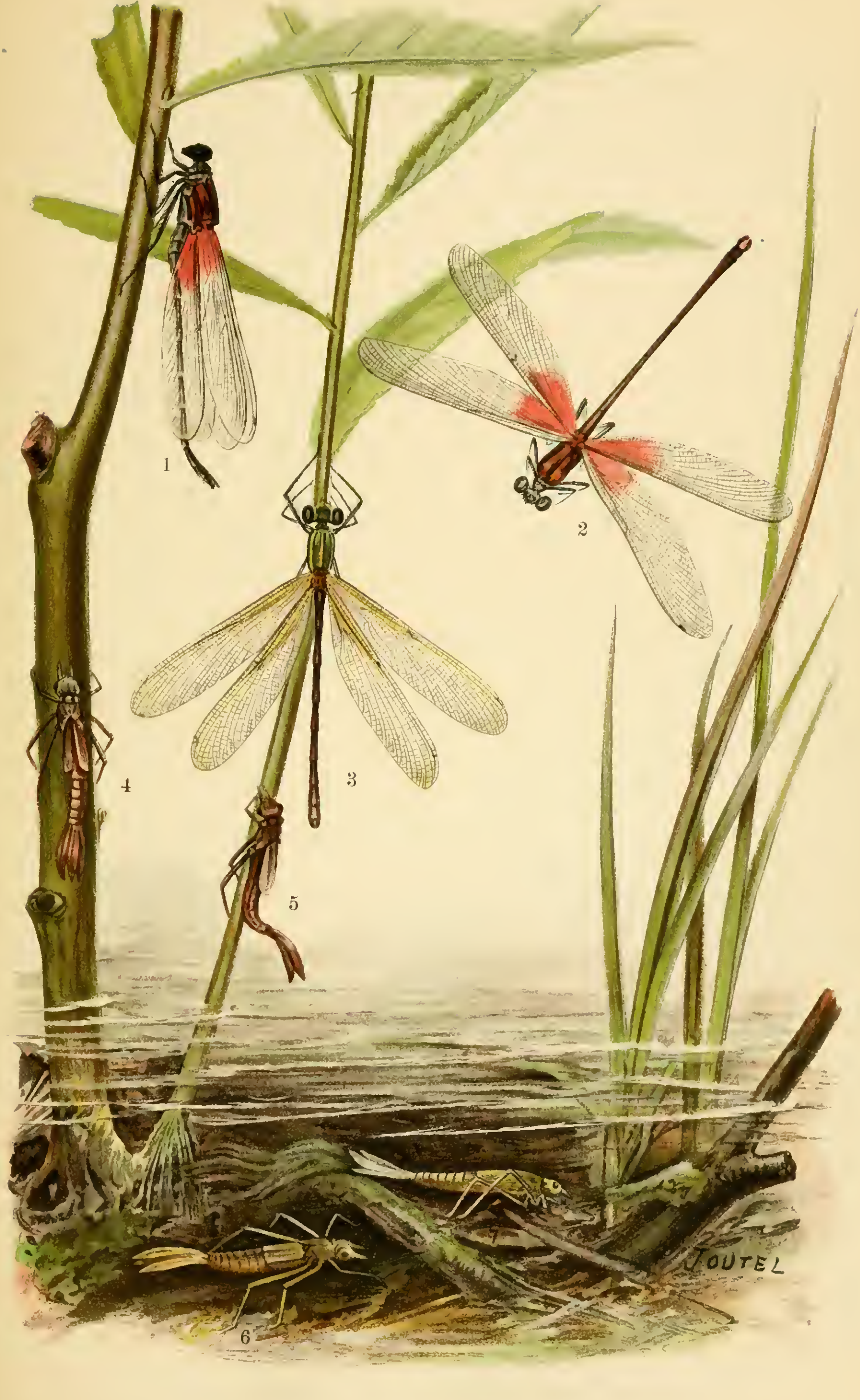


Larvae and pupa of Diptera



♀ ♂

Black-wings (Calopteryx maculata)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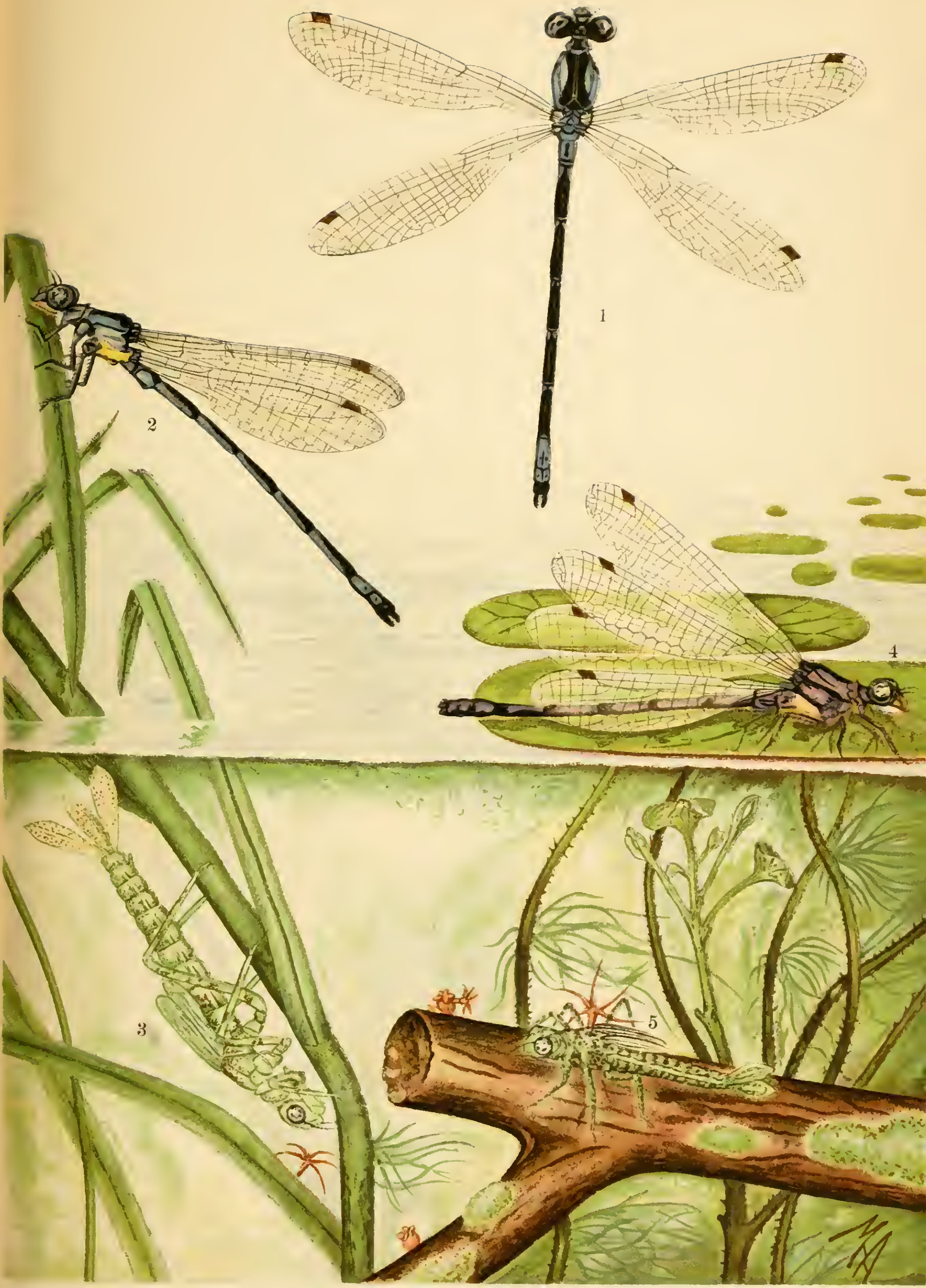
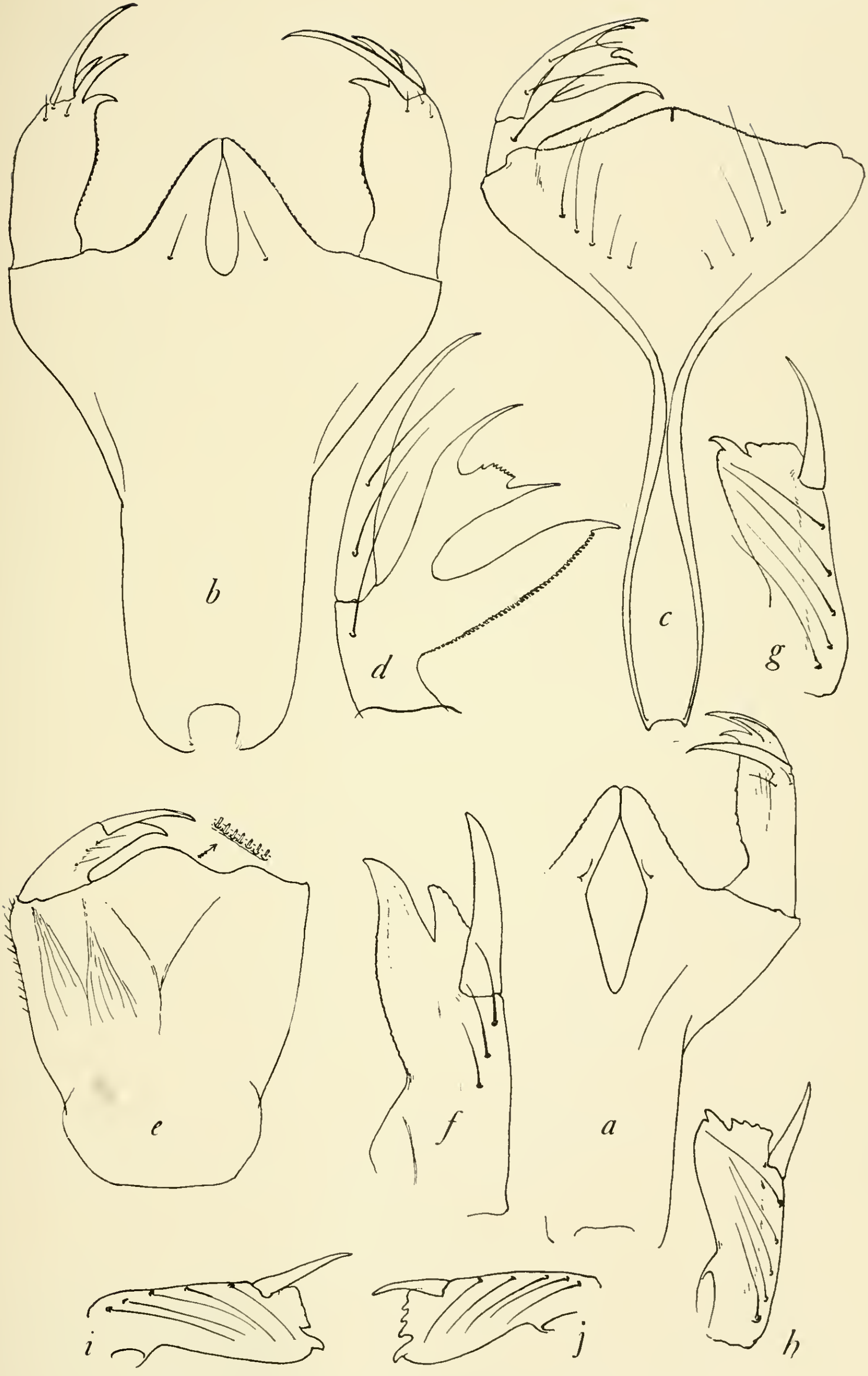
L. H. Joutel, 1902

Hetaerina americana



Chromagrion conditum and Argia violacea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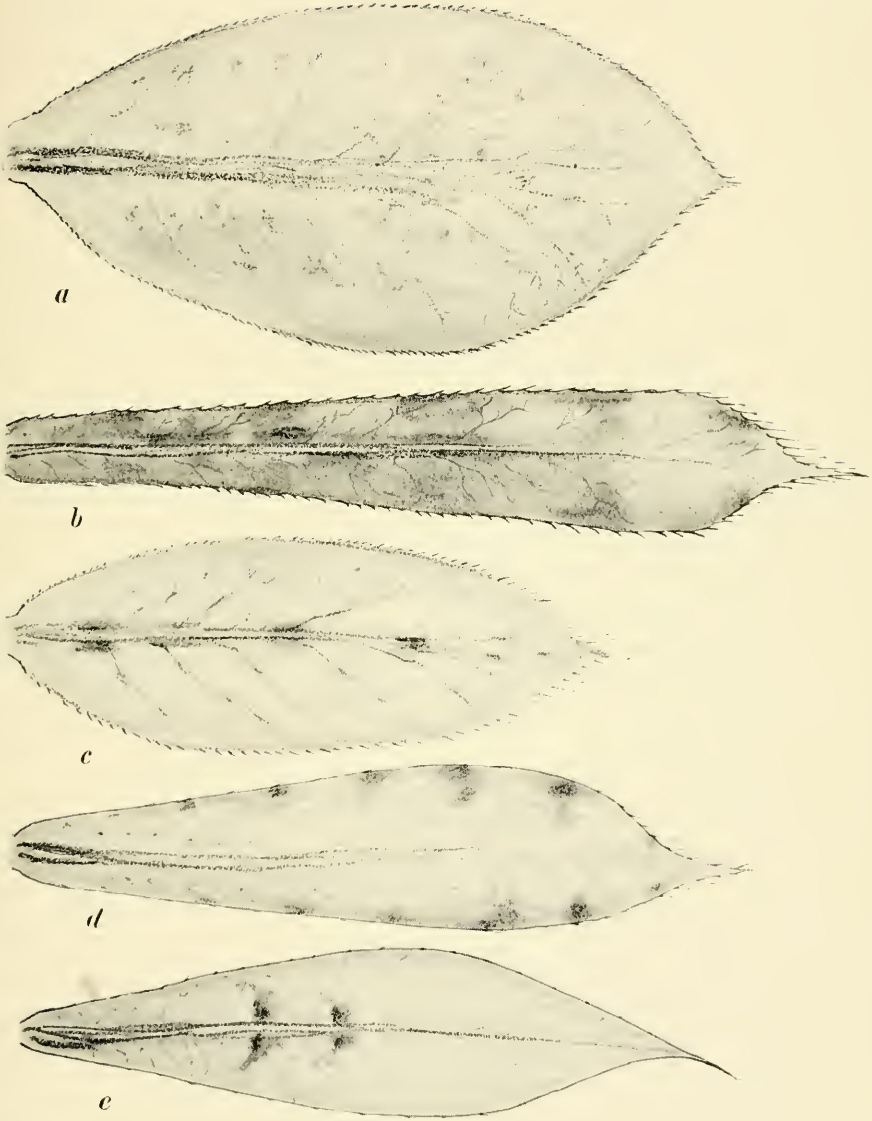
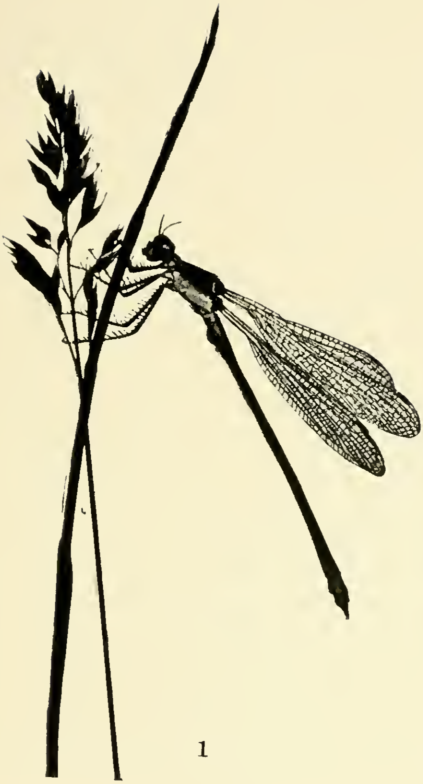
Labia of damsel fly nymphs

Plate 15



Median gill plates of damsel fly nymphs

Plate 16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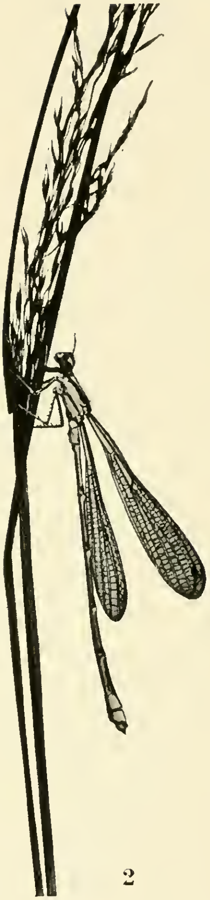
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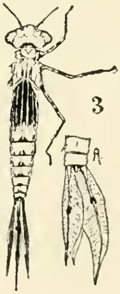
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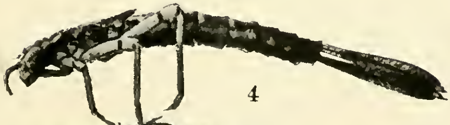
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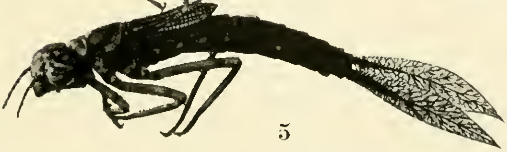
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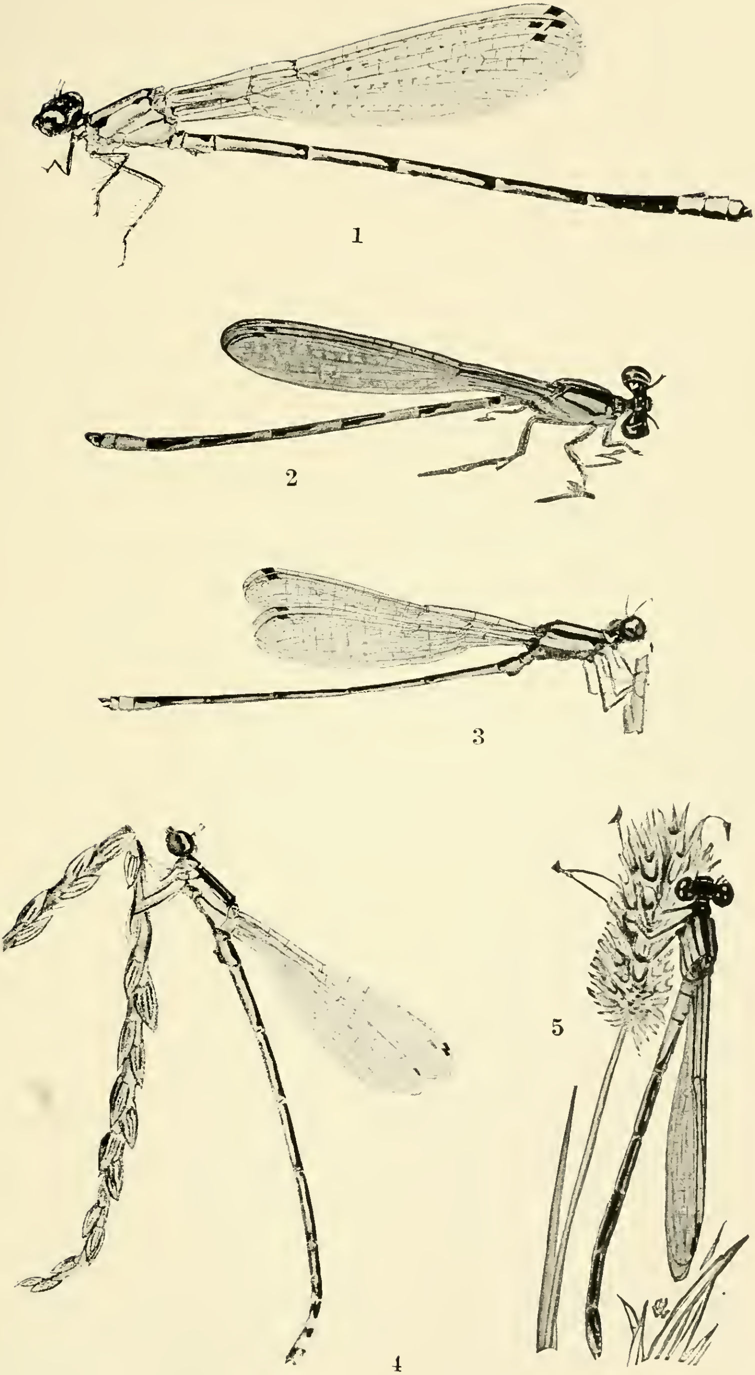
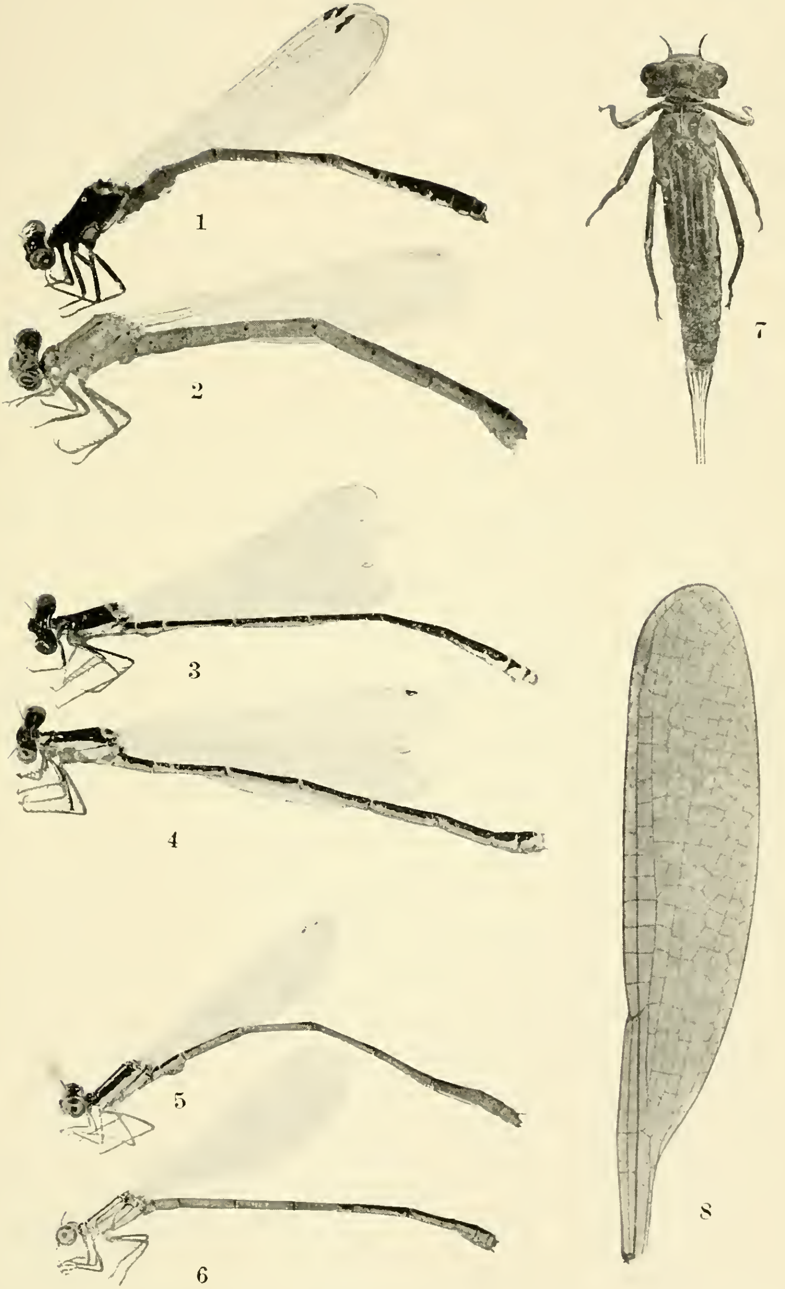
Damsel flies

Plate 17



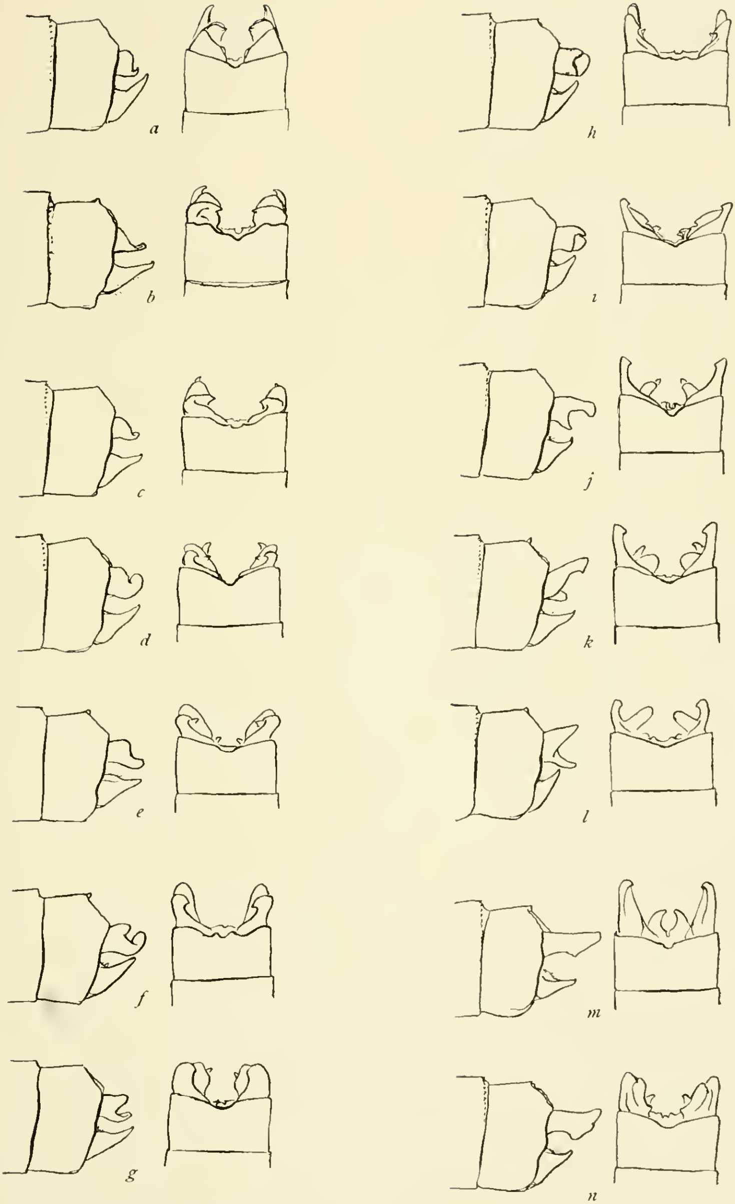
Damsel flies

Plate 18



Damsel flies

Plate 19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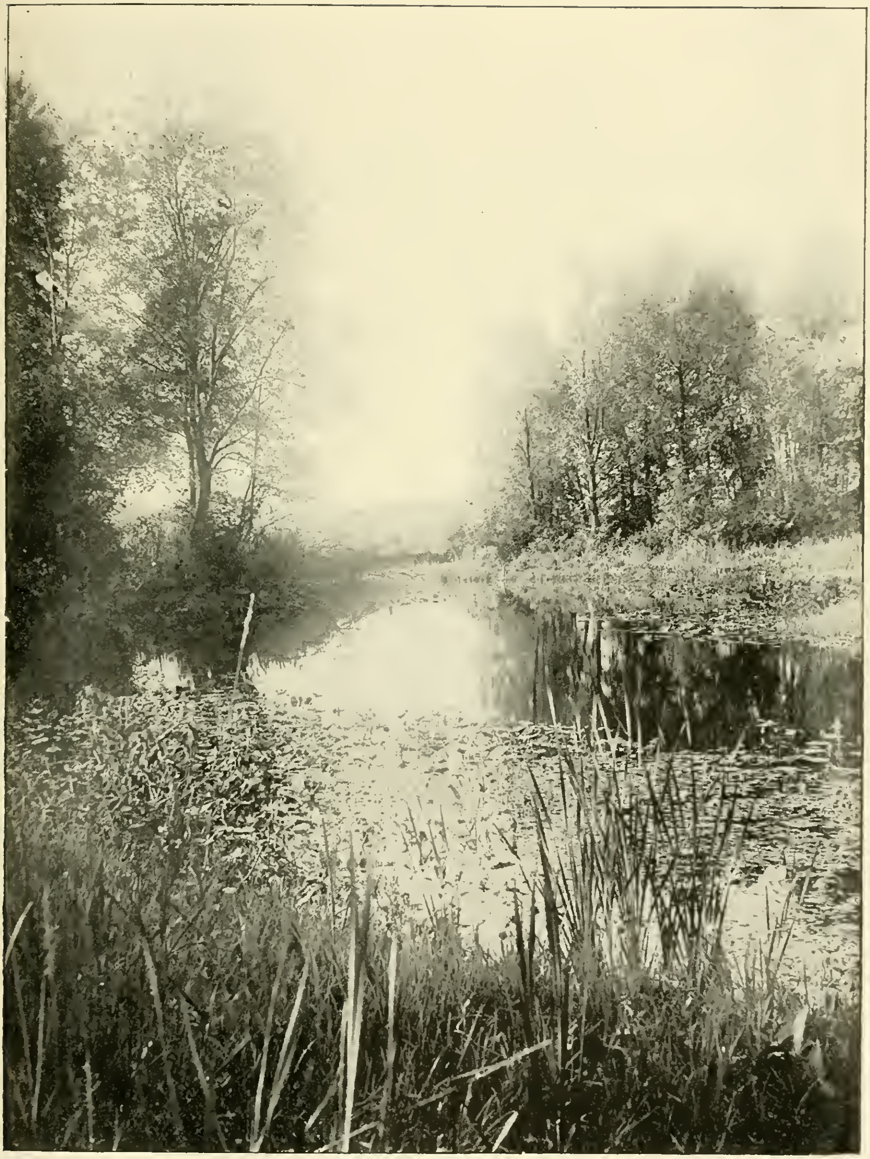
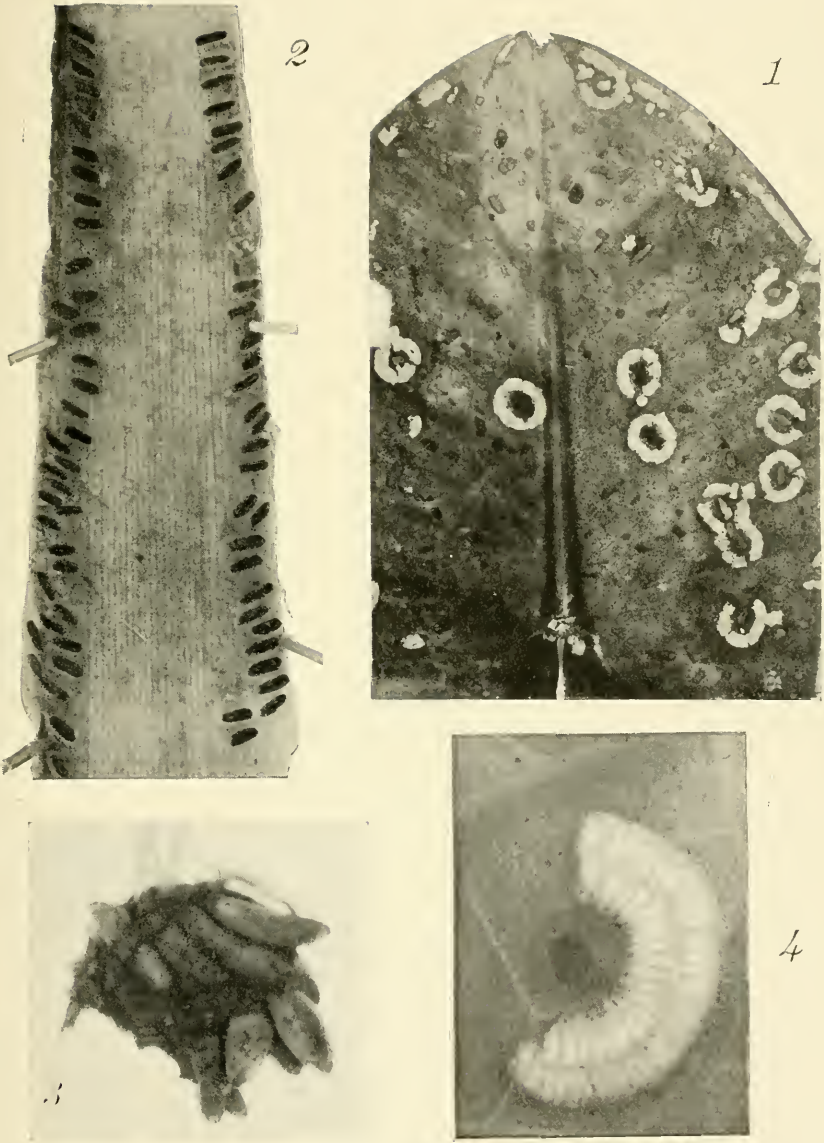
Abdominal appendages of New York species of Enallagma



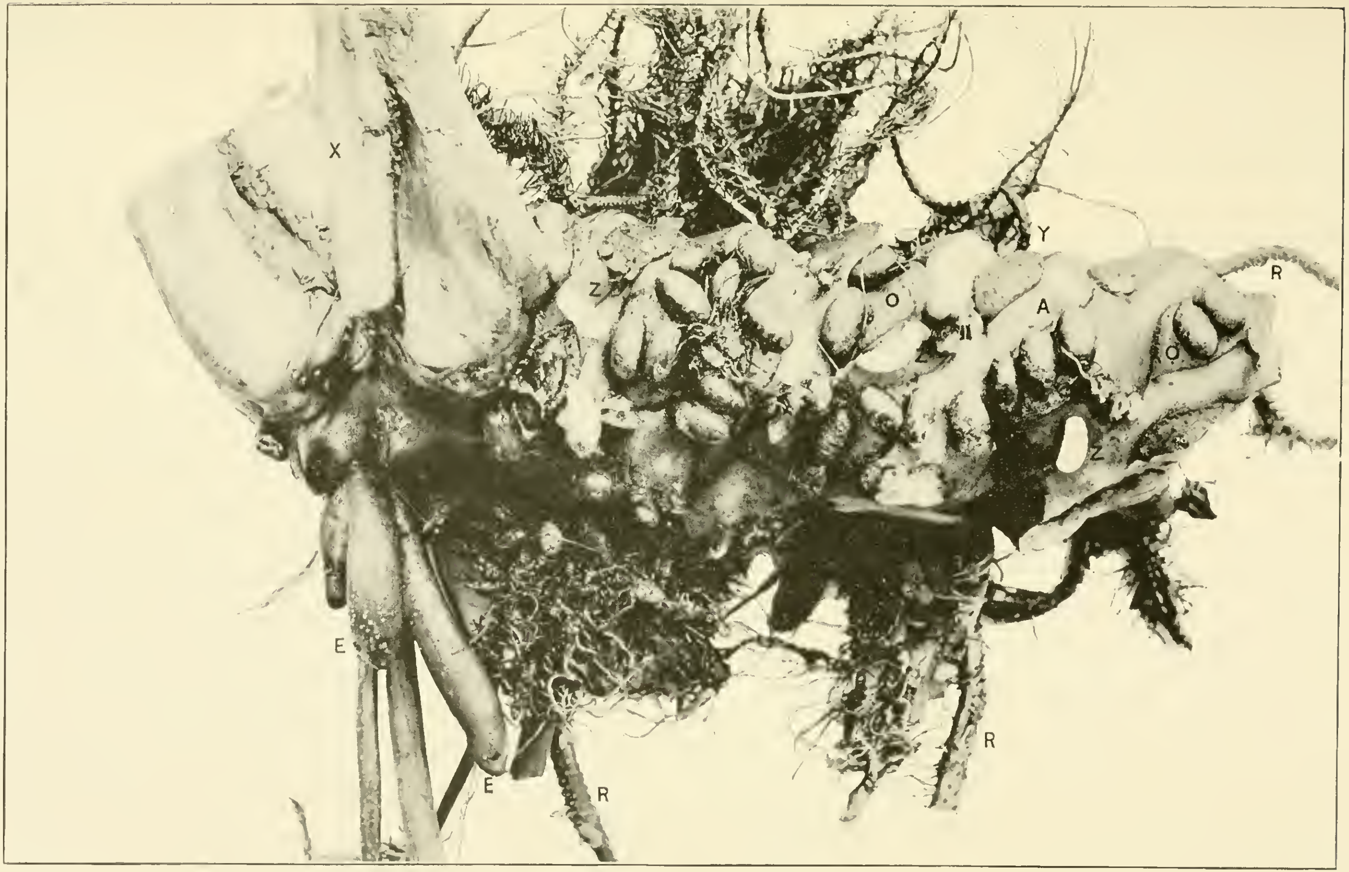
View near the outlet of Renwick lagoon, looking southeast

Plate 21

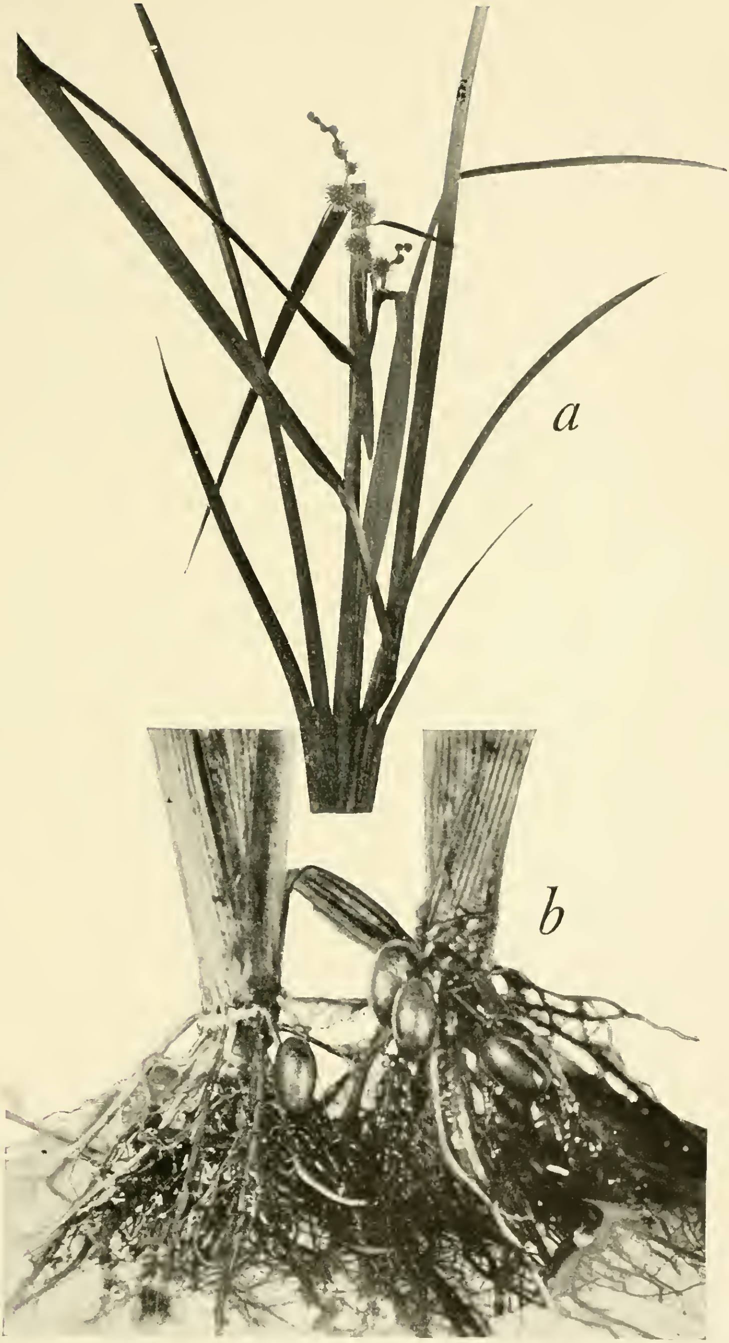


Eggs of Donacia

Plate 22

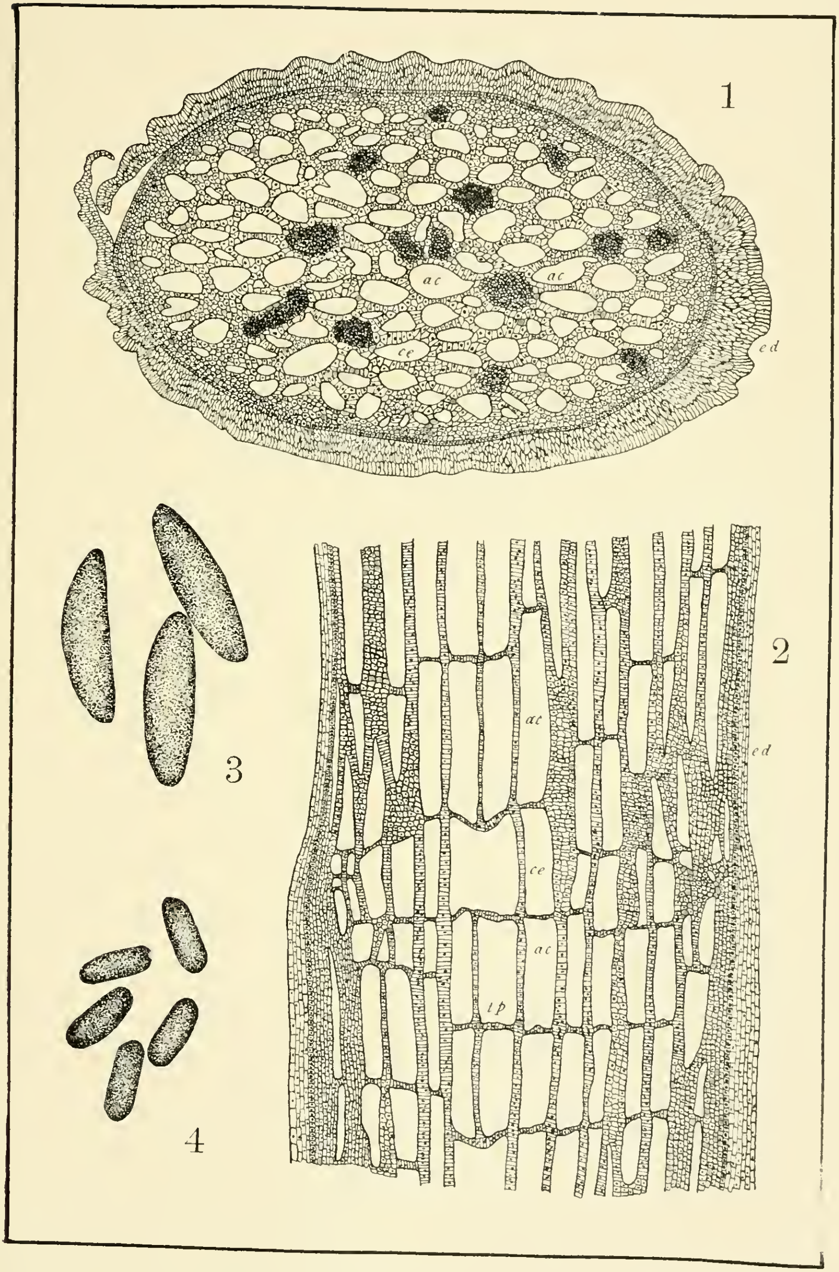

X
Y
R
Z
O
A
Z
O
Z
E
E
R
R

Root stalk of Nymphaea advena with larvae and cocoons of Donacia palmata attached



Sparganium with long horned leaf beetles (Donacia): larval and pupal cases on the roots

Plate 24


1
ac
ac
ce
ed
2
ac
ed
ce
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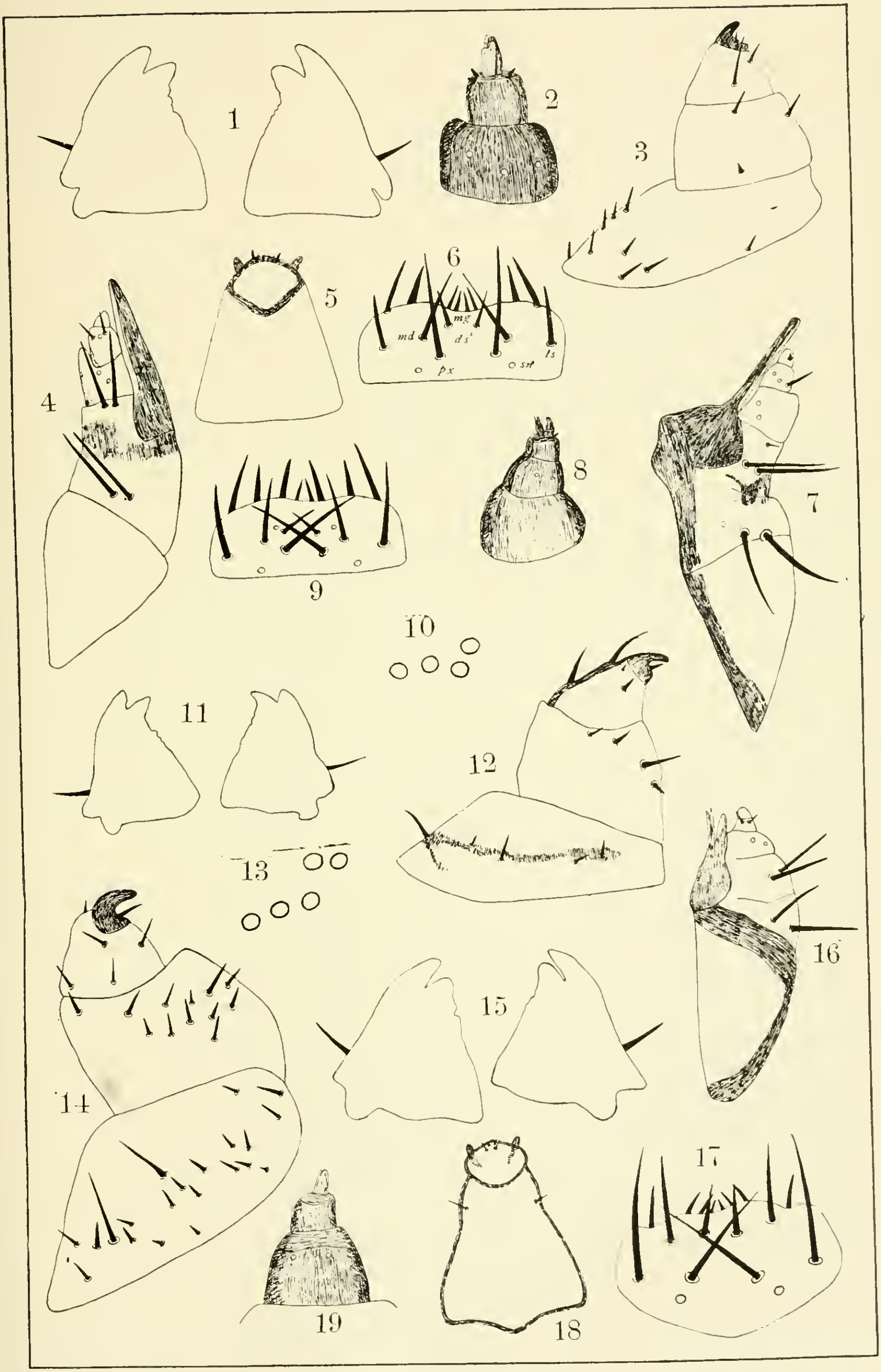
ip
3
4

Sections of stem of Sagittaria and eggs of Donacia


1
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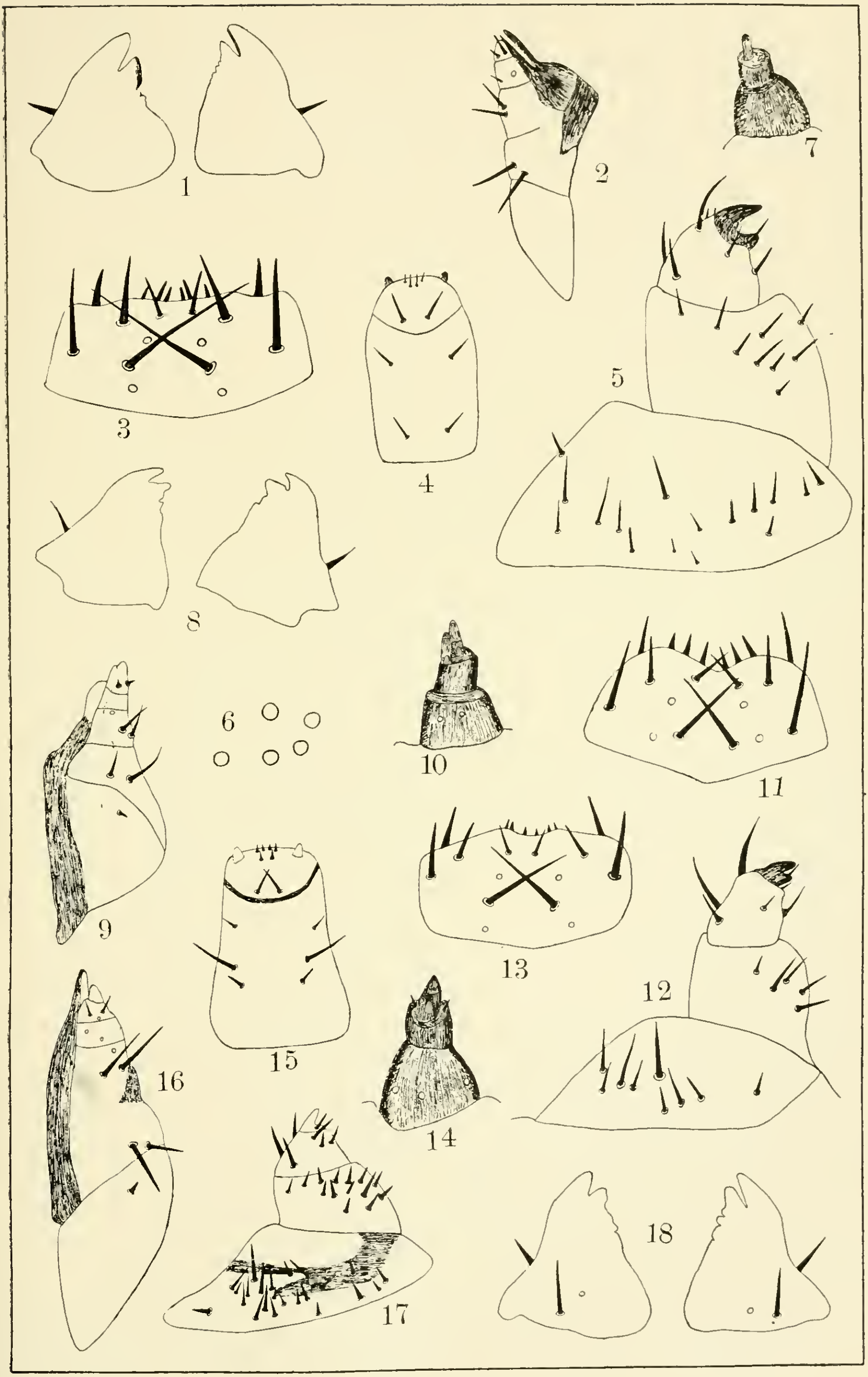
Anatomic details of Donacia larvae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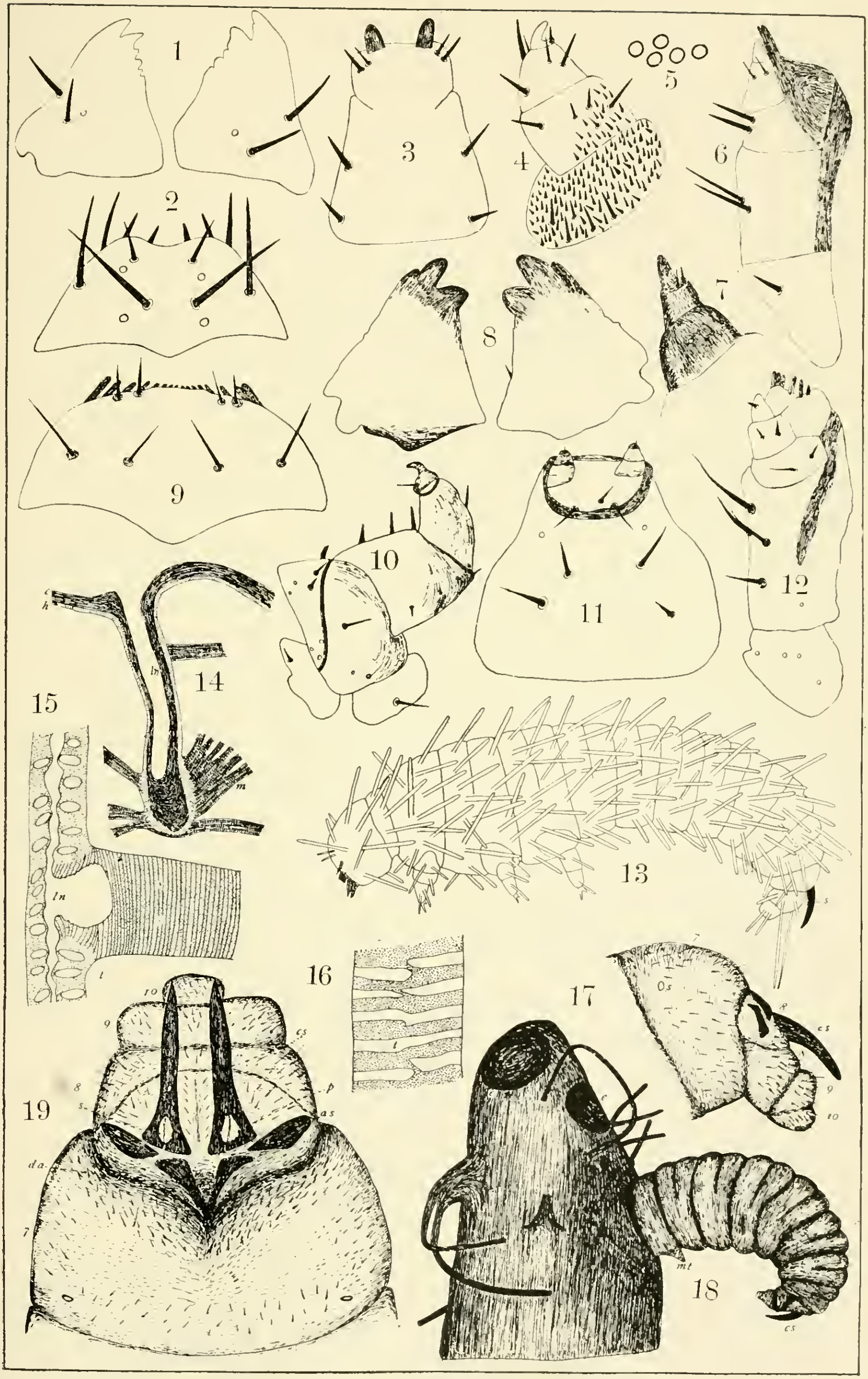
Anatomic details of Donacia larvae

Plate 27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13
s
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ln
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16
l
17
7
Os
8
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9
10
18
e
mt
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19
10
9
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8
p
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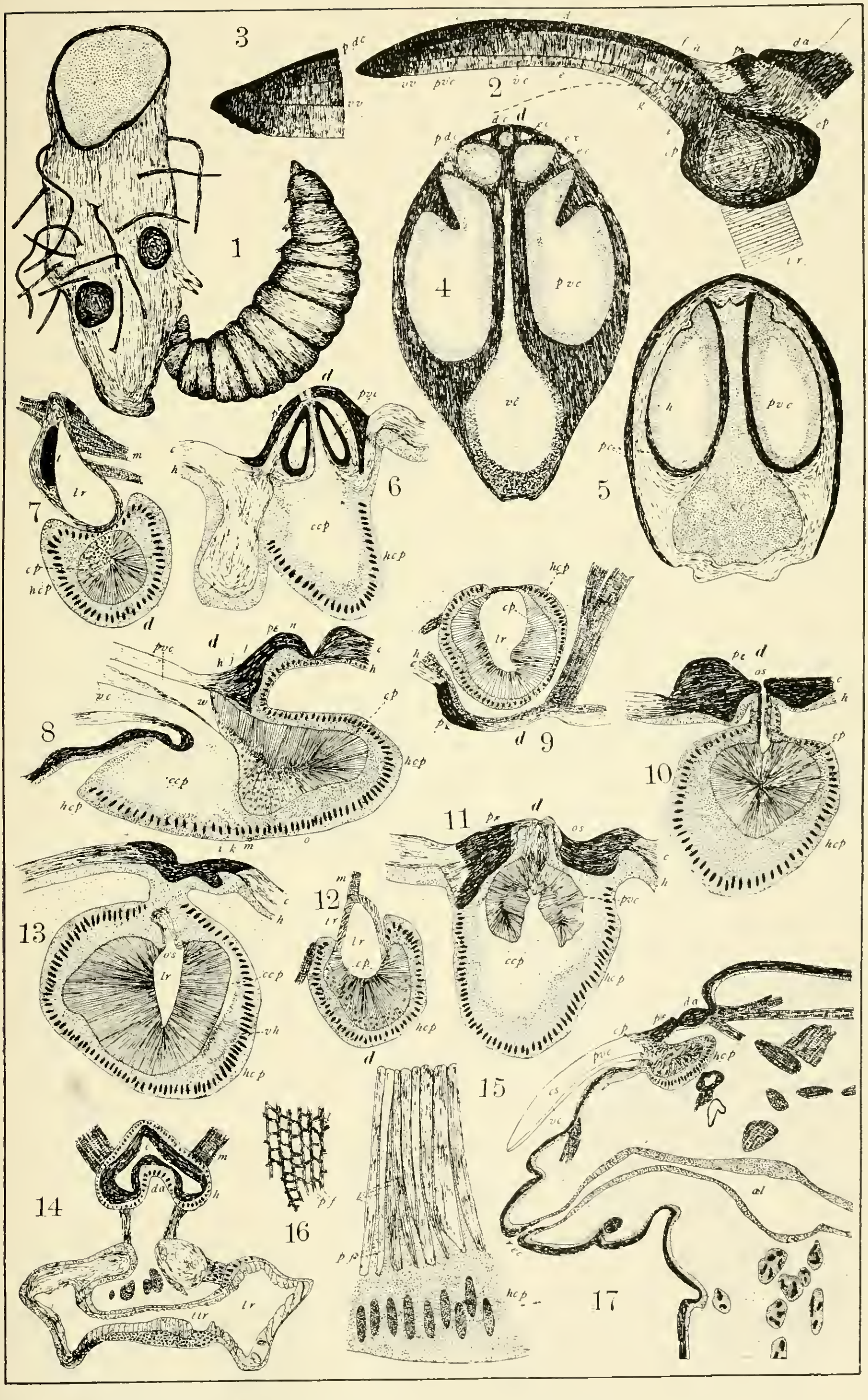
7

Anatomic details and the respiratory apparatus of *Donacia palmata*


3
p dc
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d
vv
pvc
vc
e
g
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pdc
dc
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5
h
pvc
vc
7
m
lr
cp
hcp
d
6
d
pvc
c
h
ccp
hcp
8
pvc
vc
d
hcp
ccp
cp
hcp
9
hcp
cp
lr
d
10
d
os
c
h
cp
hcp
11
d
os
c
h
pvc
ccp
hcp
13
c
h
os
lr
ccp
vh
hcp
12
m
tr
lr
cp
hcp
14
m
da
h
lr
tlr
16
pf
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d
pf
hcp
17
da
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pvc
hcp
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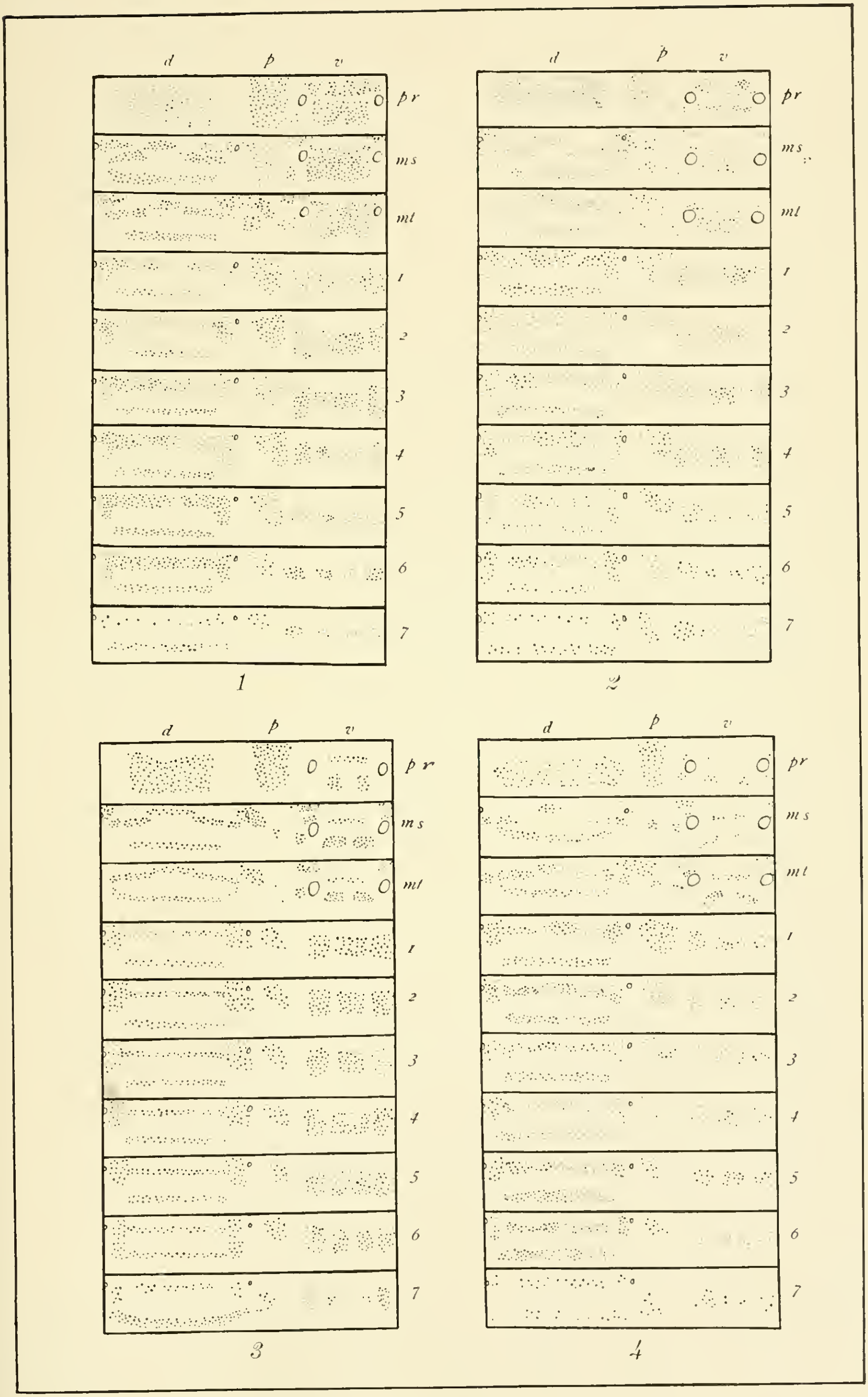
Anatomic details of the dorsal spines of Donacia palmata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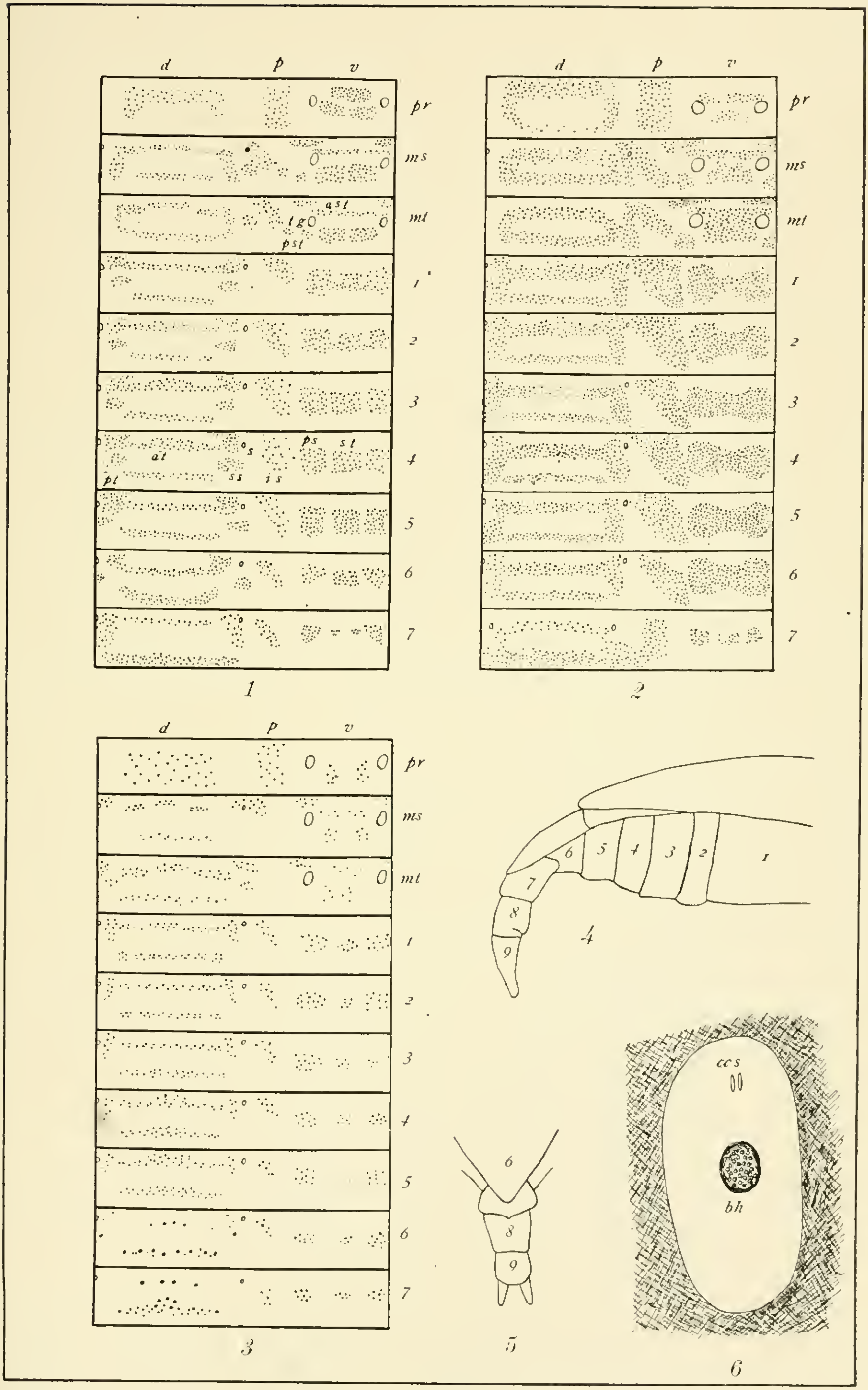
Setal arrangement in Donacia larvae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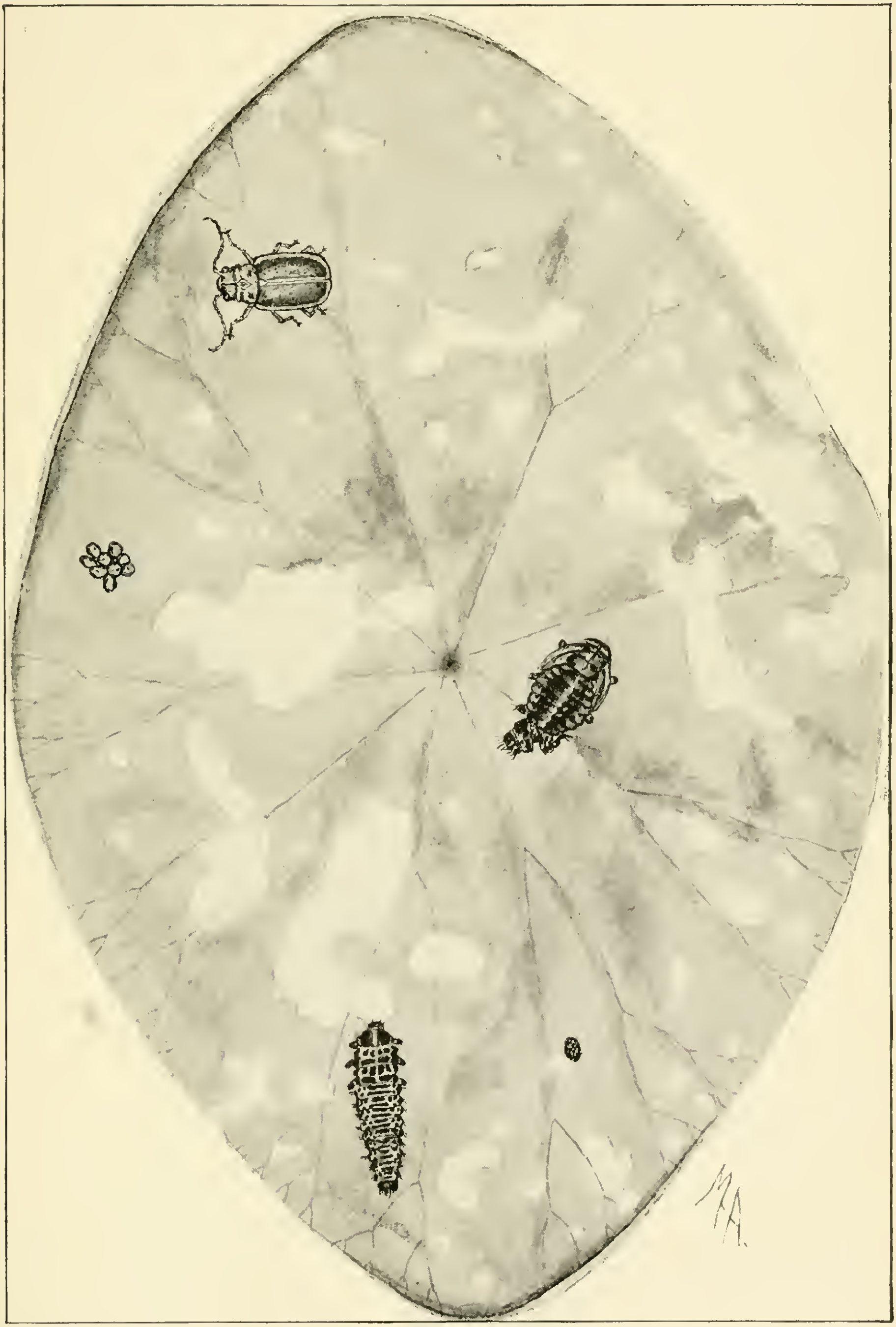
ccs
bh

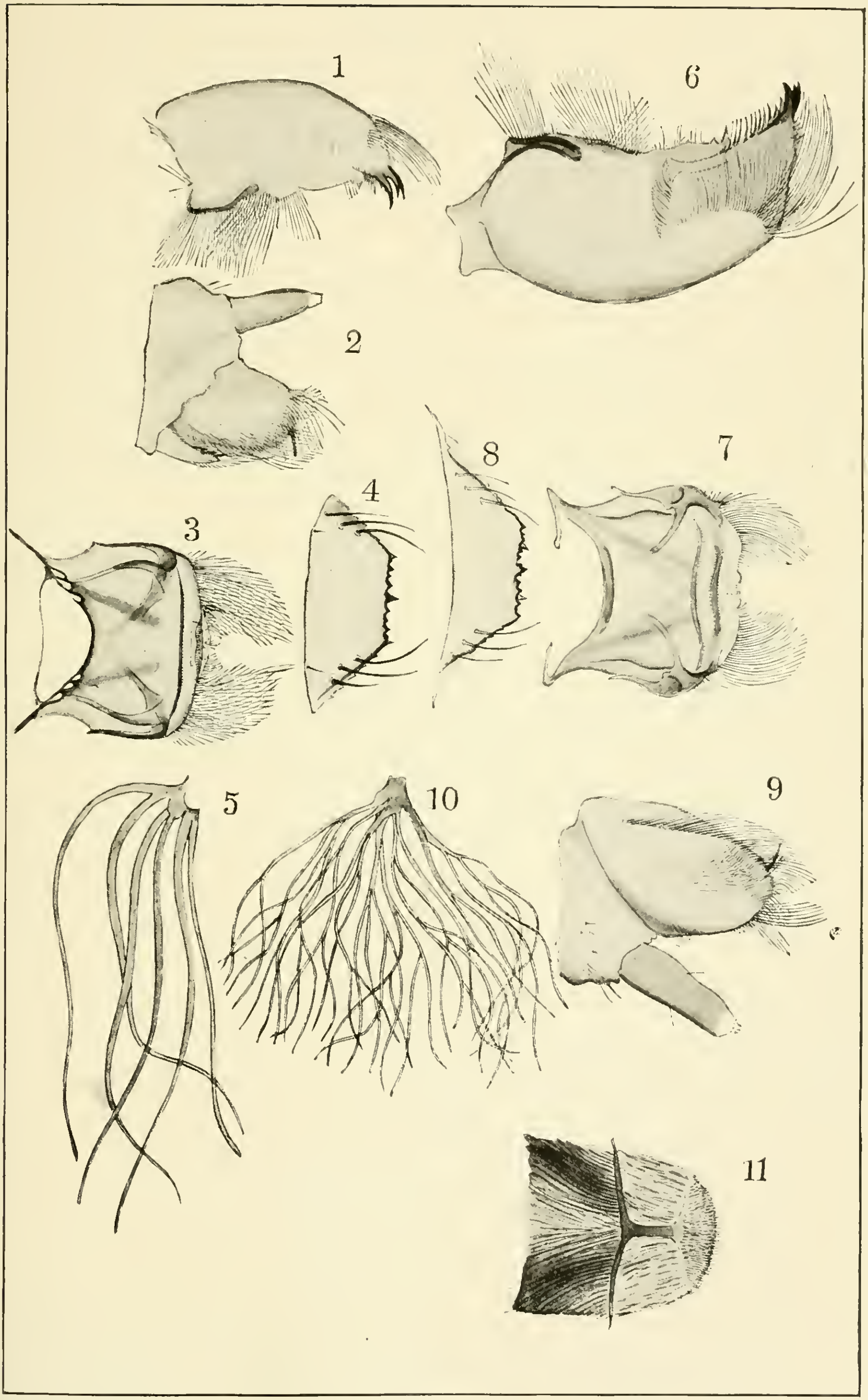
Setal arrangement in Donacia and Haemonia larvae and anatomic details of Donacia palmata



Food plant and transformations of *Galerucella nymphaeae*

Cascadilla creek

Plate 33


1
6
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8
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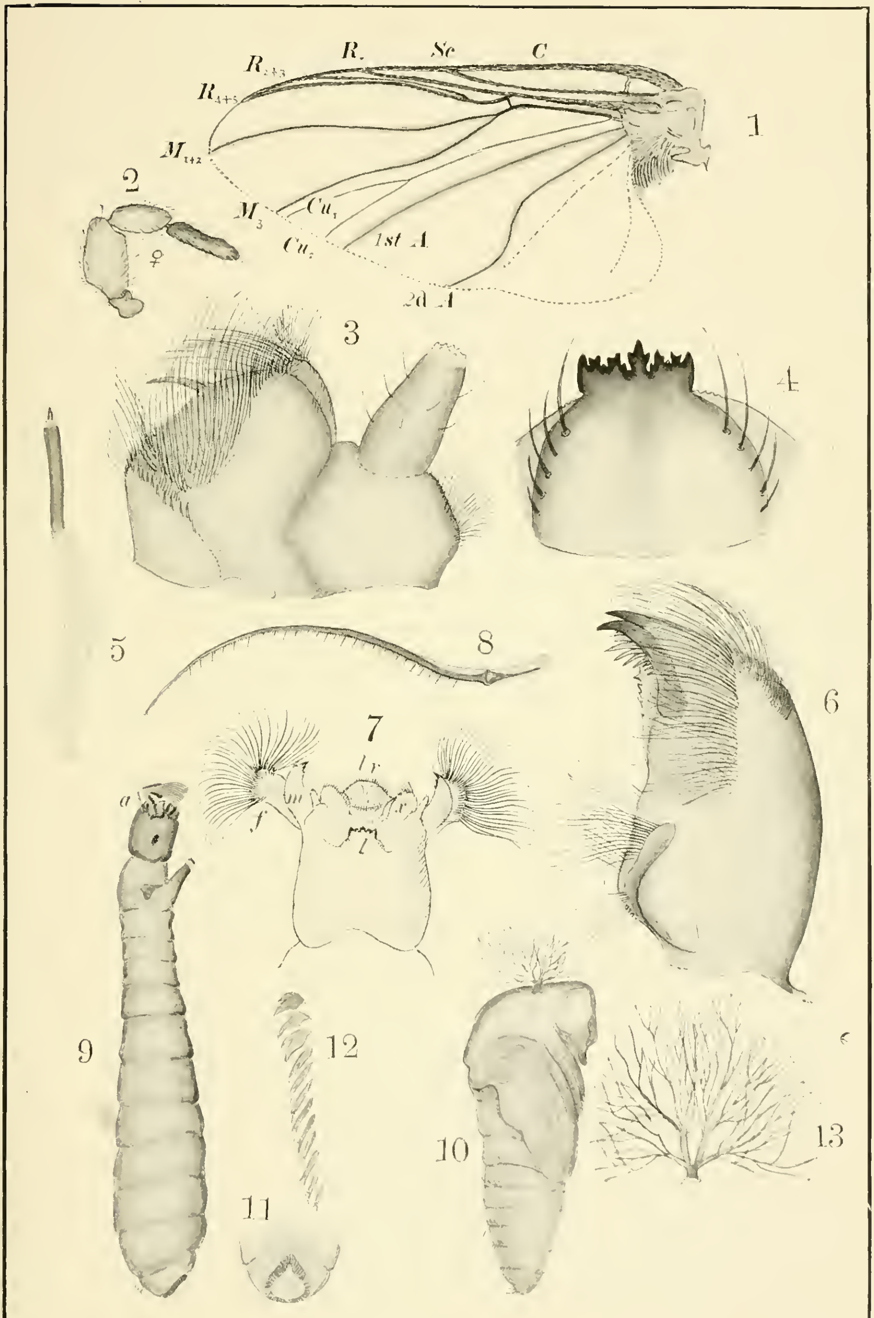
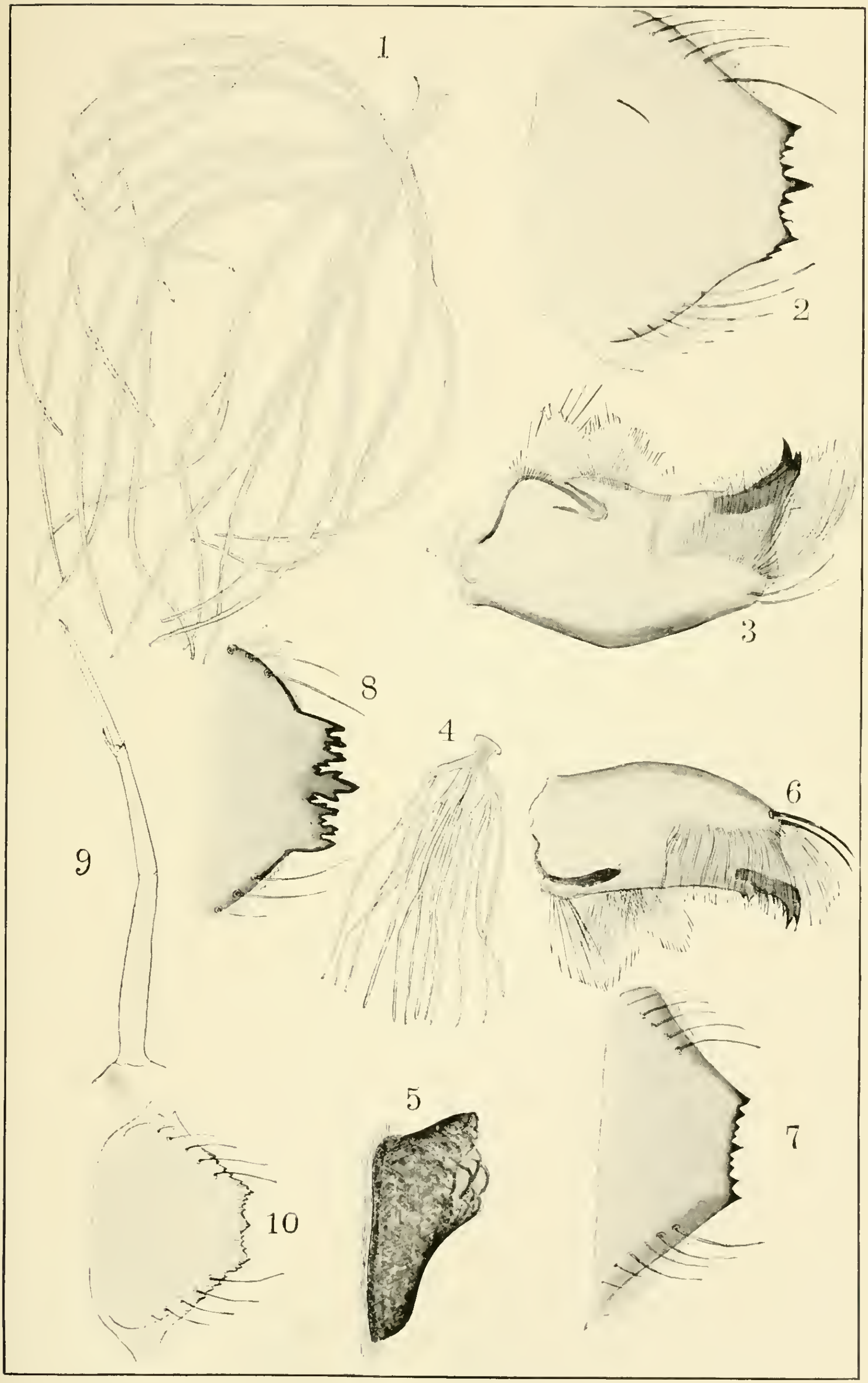
11

Details of Simulium larvae and pupae (S. pecuarum and meridionale)


1
R.
Sc
C
R2+3
R4+5
M1+2
M3
Cu1
Cu2
1st A
2d A
2
♀
3
4
5
6
7
lr
m
x
f
l
8
a
9
10
11
12
13

Simulium hirtipes


1
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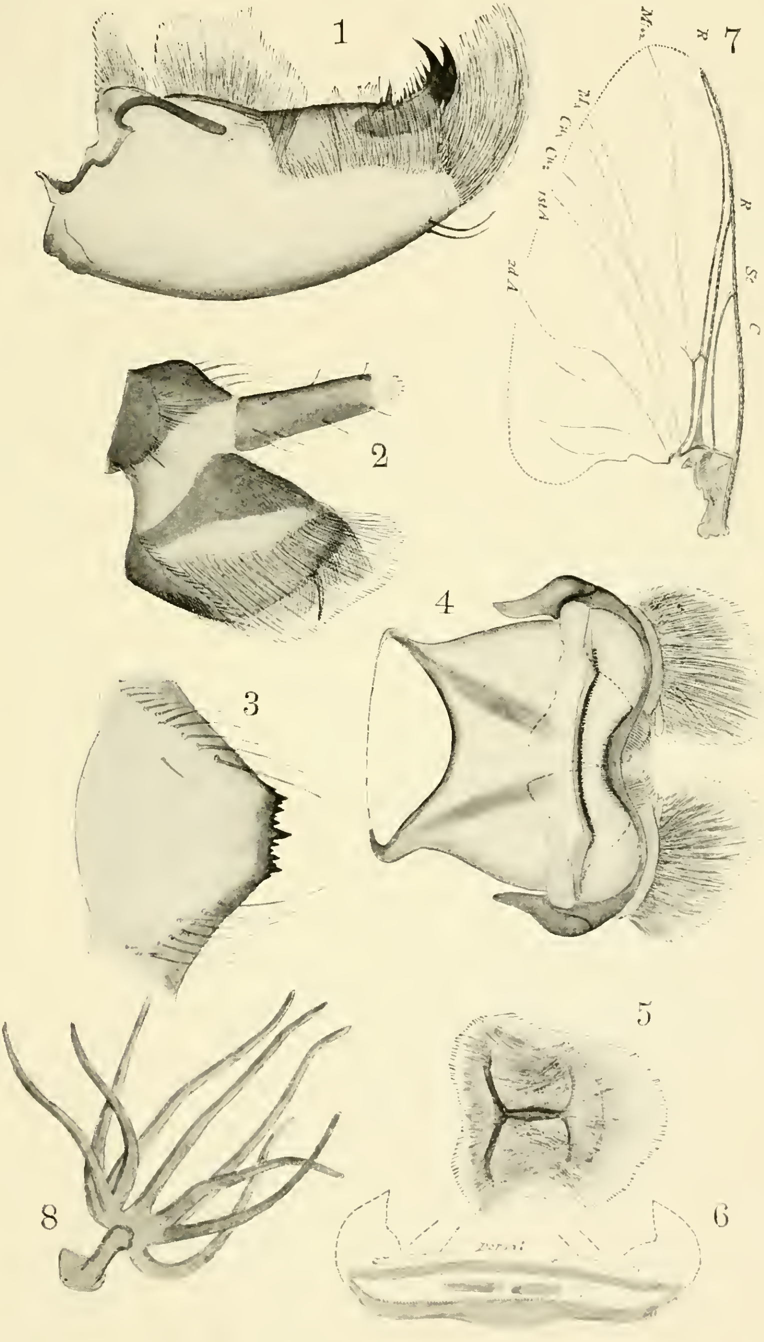
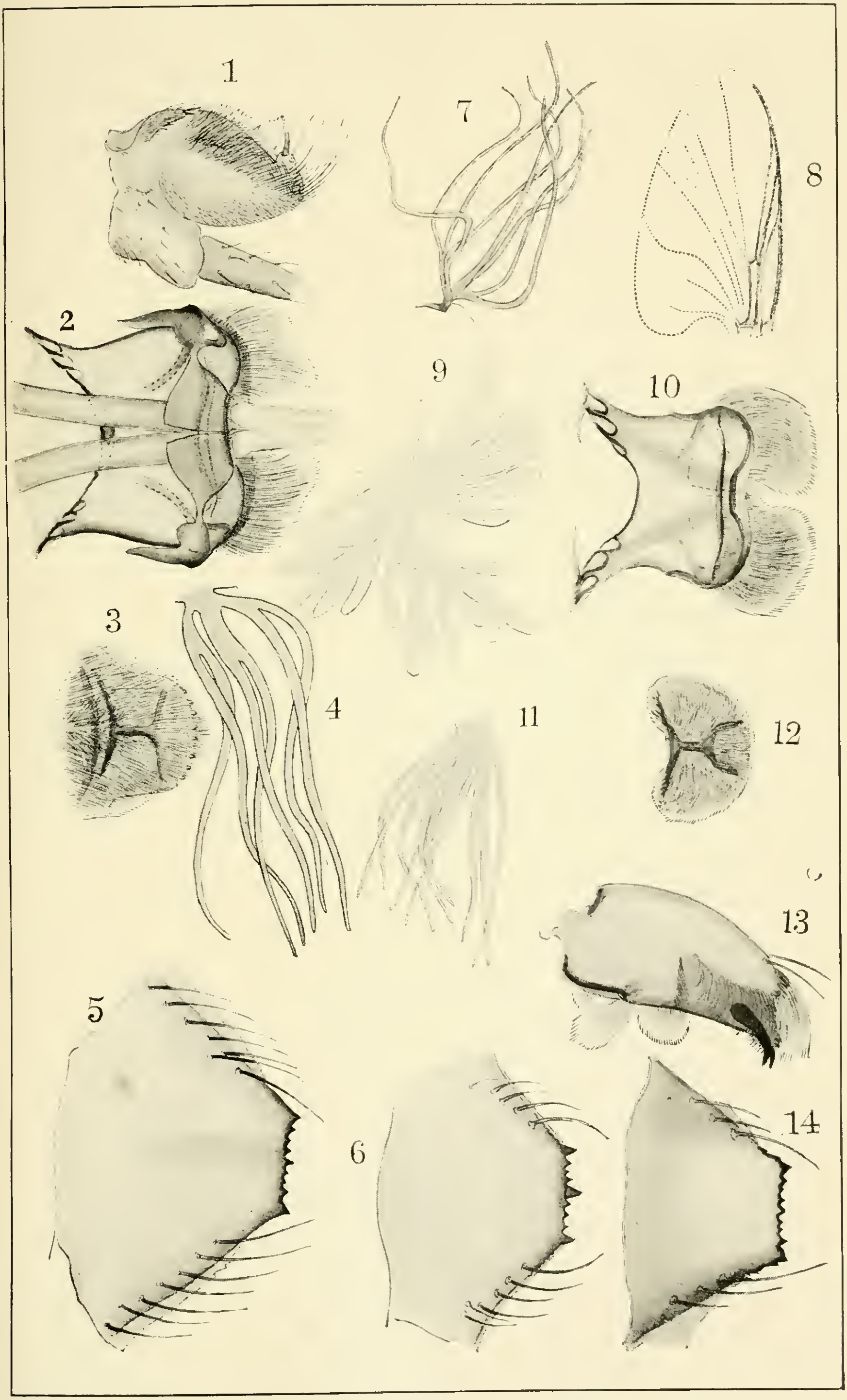
Details of Simulium larvae and pupae (S. vittatum and others)


1
7
M_{1+2}
R
M_3
Cu_1
Cu_2
1st A
2d A
R
Sc
C
2
4
3
5
8
6

Simulium pictipes


1
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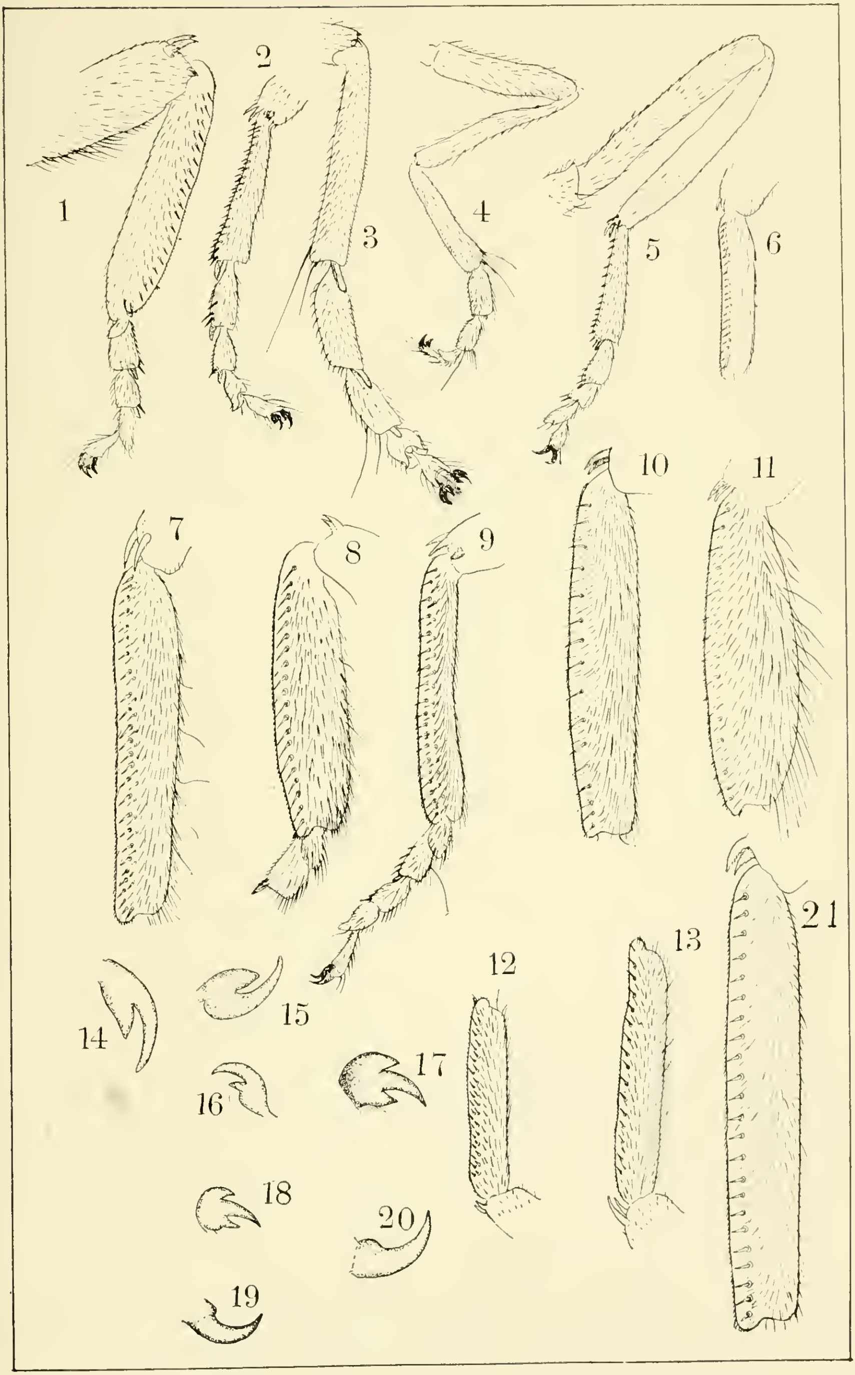
14

Simulium venustum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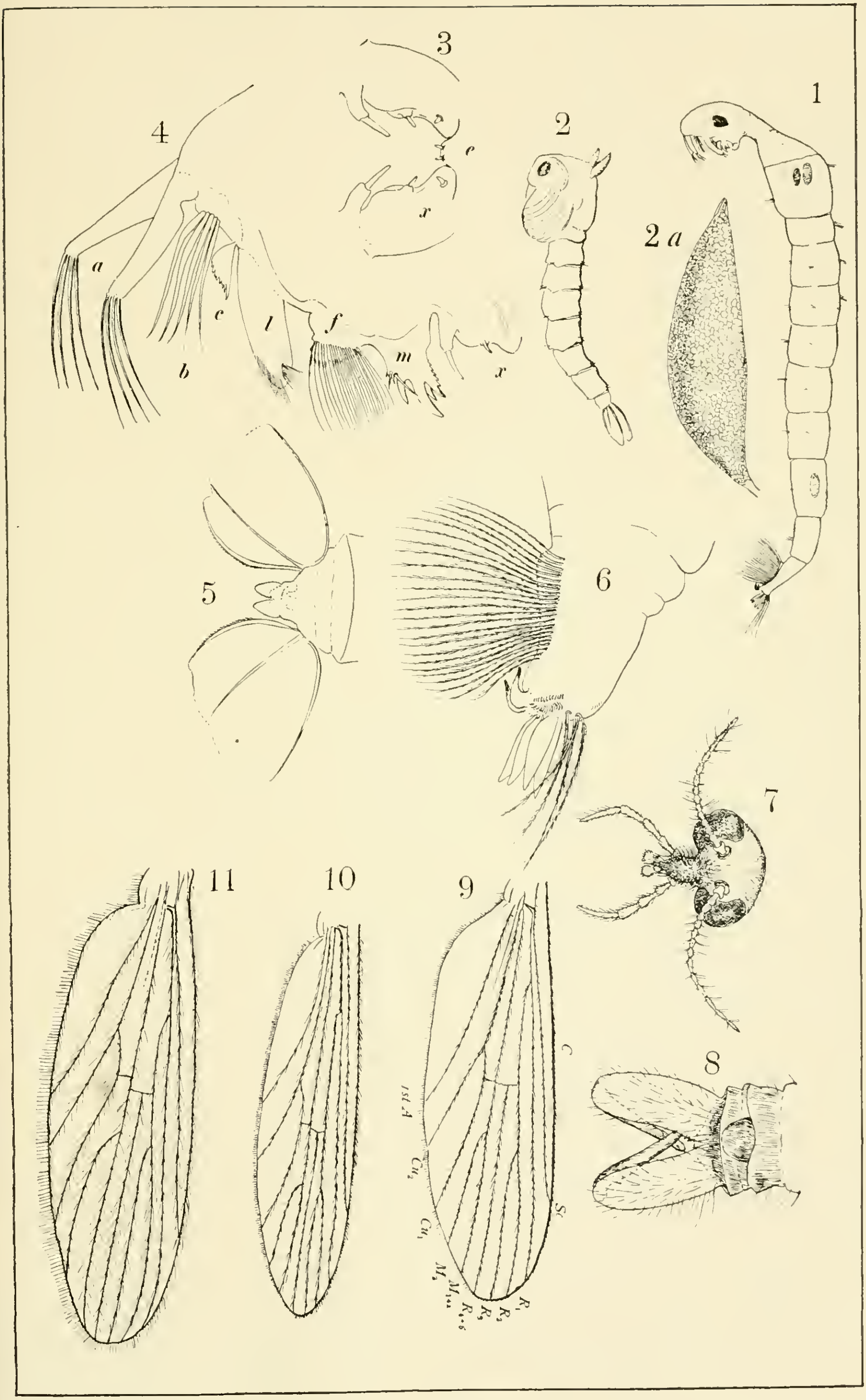
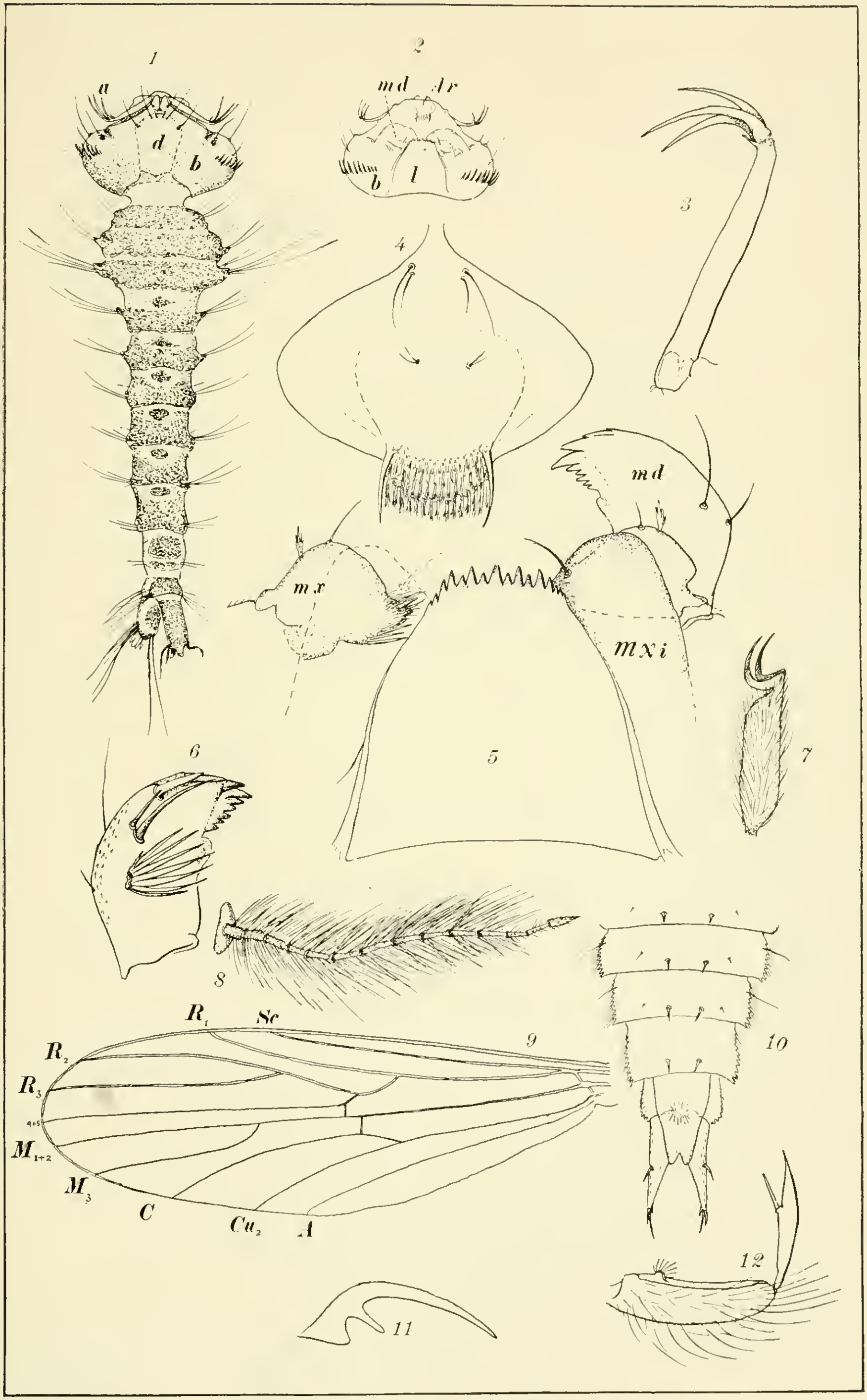
21

Legs and Claws of Simulium *sp.*

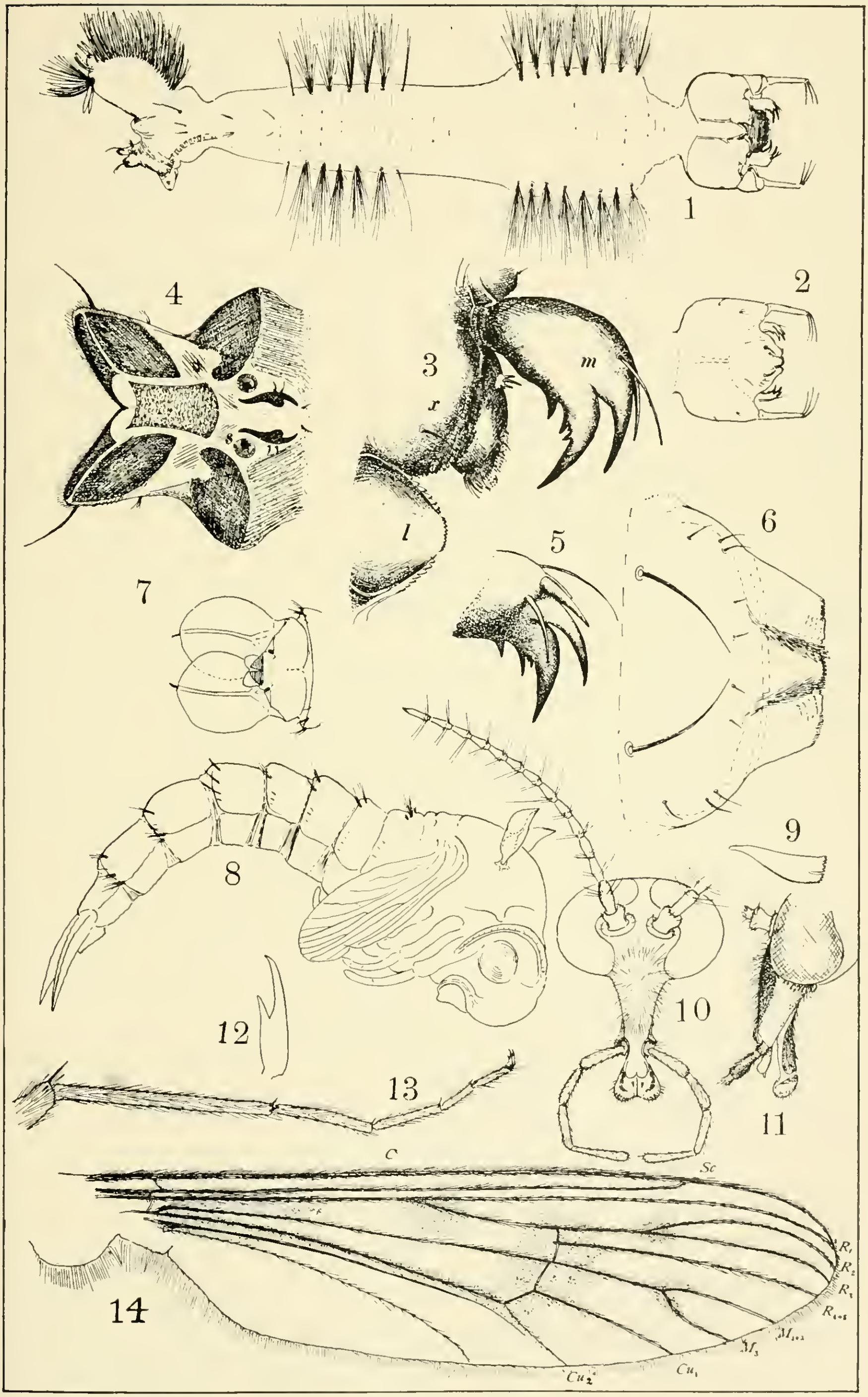
Plate 39


1
2
2 a
3
4
5
6
7
8
9
10
11
a
b
c
l
f
m
x
e
x
C
1st A
Cu2
Cu1
Sc
M3
M1+2
R1
R2
R3
R4+5

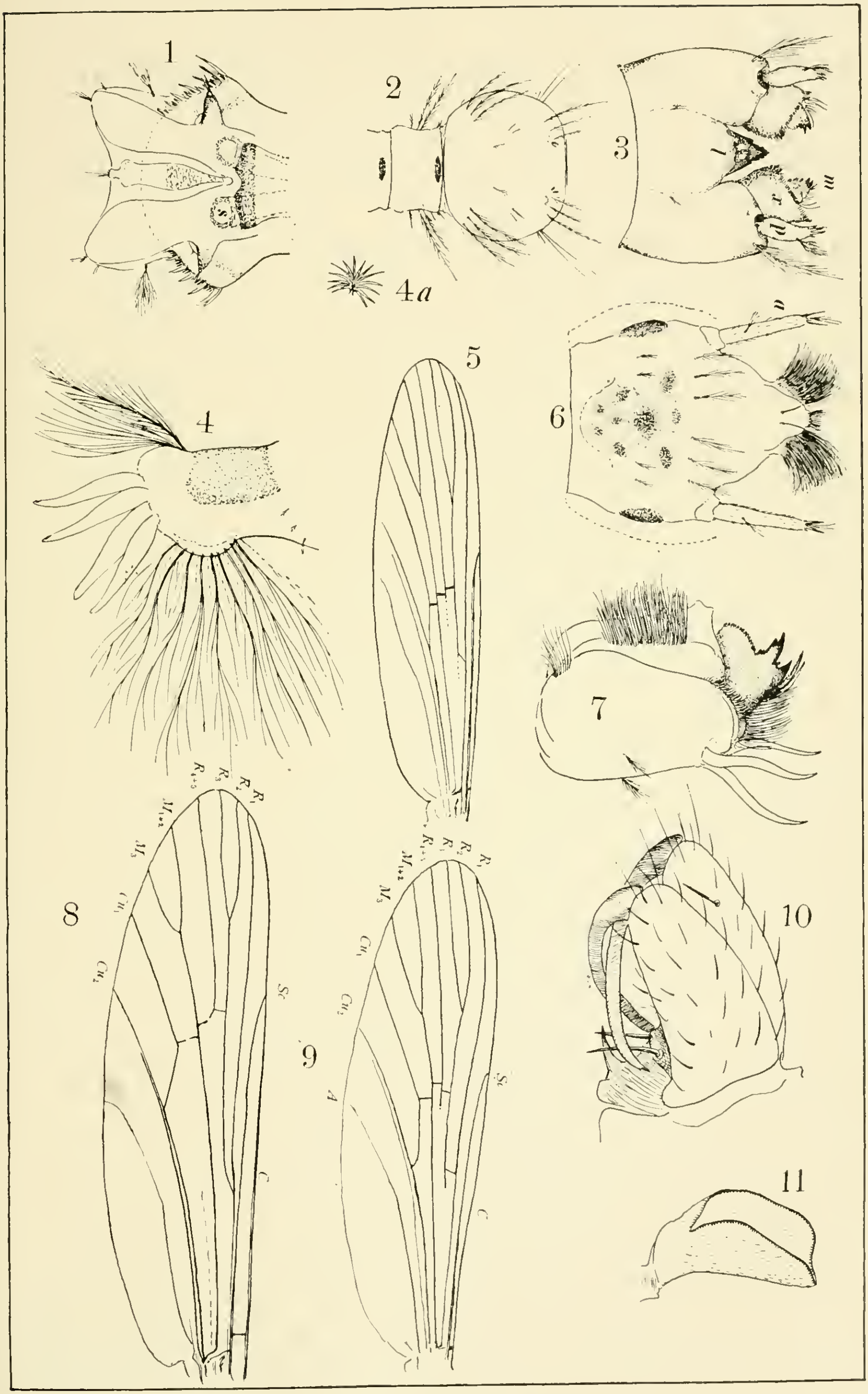
Corethra


1
a
d
b
2
md
lr
b
l
3
4
md
mx
mxi
5
6
7
8
R₁
Sc
9
R₂
R₃
4+5
M₁₊₂
M₃
C
Cu₂
A
10
11
12

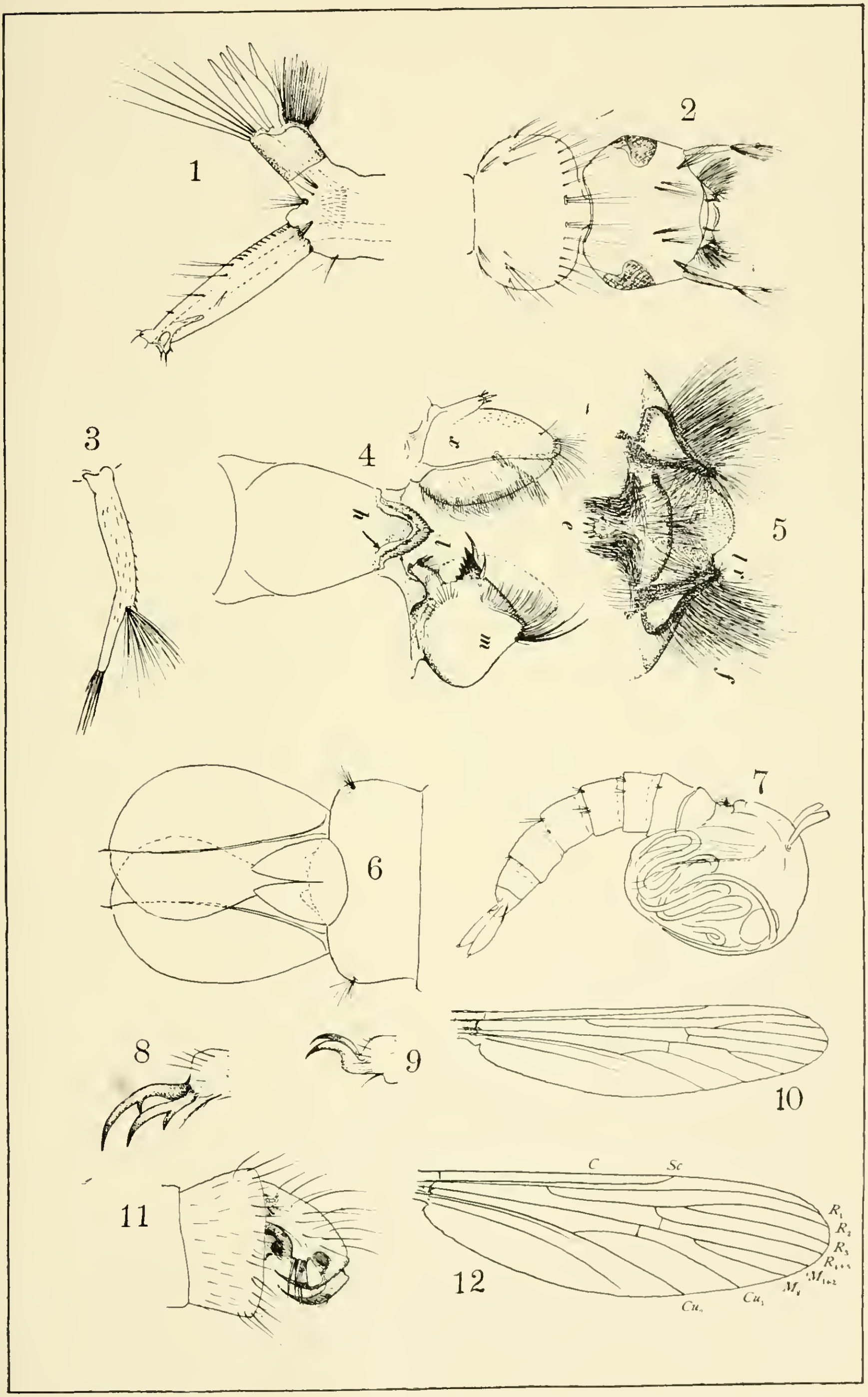
Corethrella brakeleyi


1
2
3
4
5
6
7
8
9
10
11
12
13
14
m
x
l
s
C
Sc
R_1
R_2
R_3
R_{4+5}
M_{1+2}
M_3
Cu_1
Cu_2

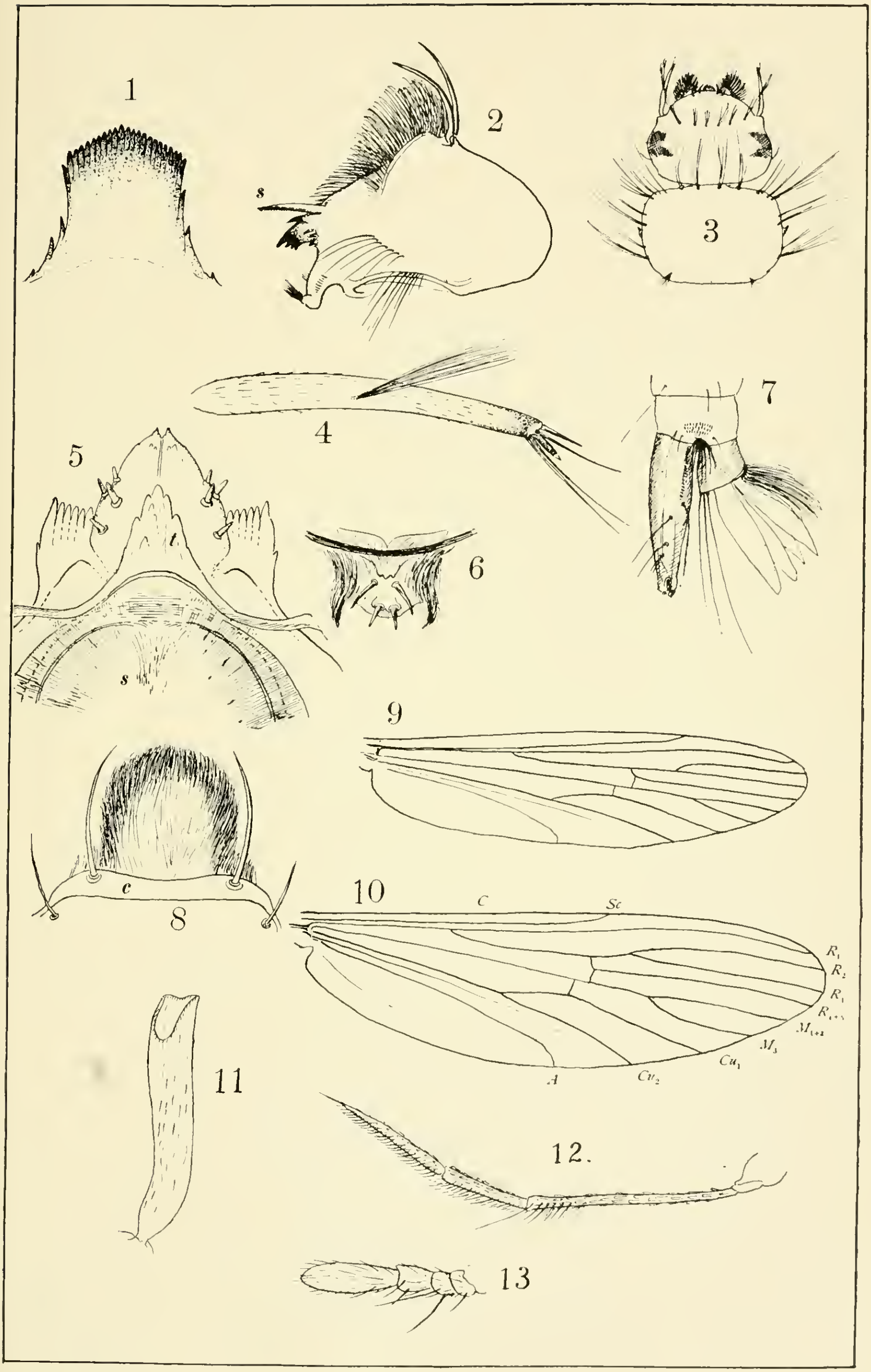
Pelorempis americana


1
2
3
4
4a
5
6
7
8
9
10
11
R1
R2
R3
R4+5
M1+2
M3
Cu1
Cu2
Sc
C
A

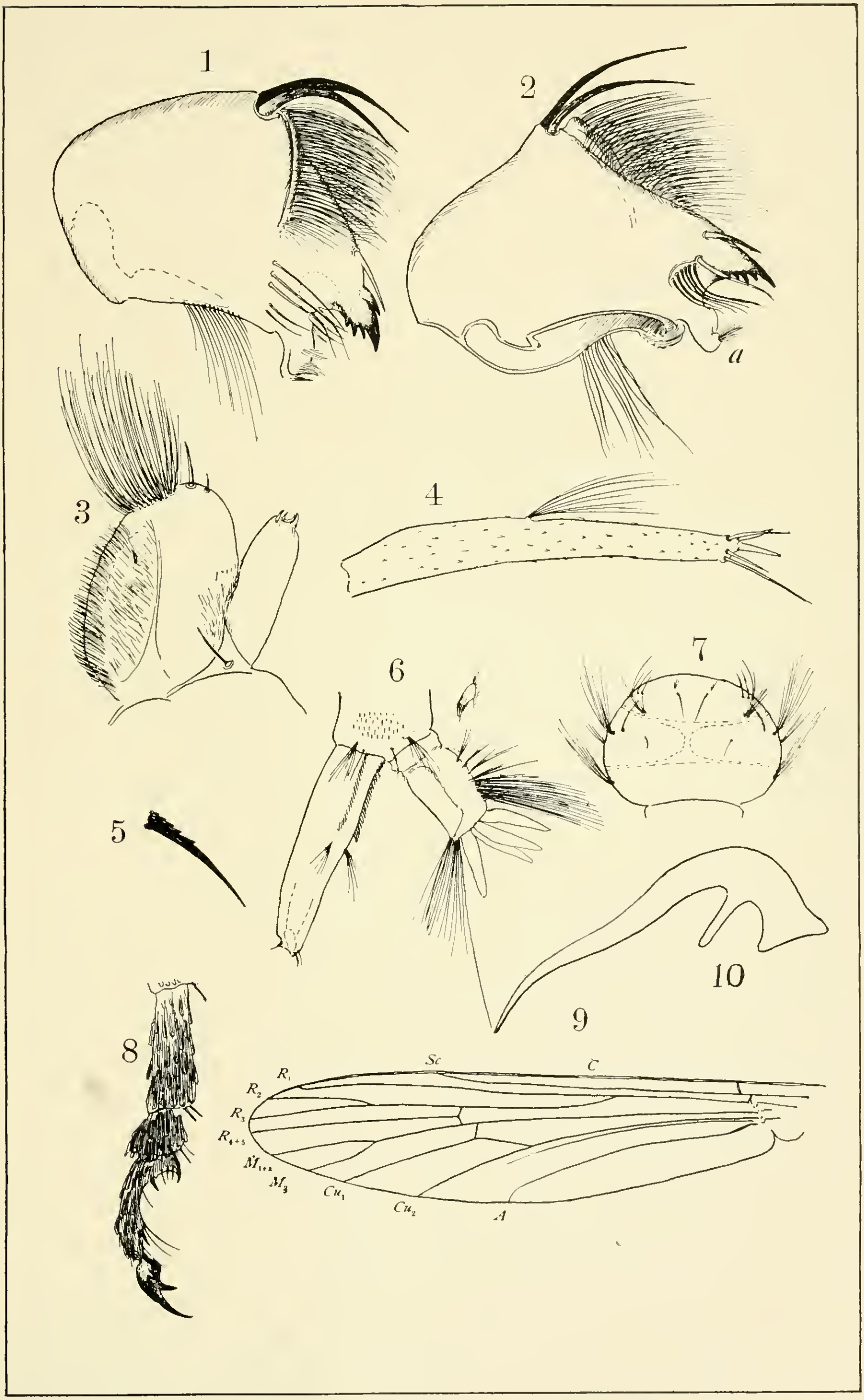
Anopheles and Psorophora


1
2
3
4
5
6
7
8
9
10
11
12
C
Sc
R1
R2
R3
R4+5
M1+2
M3
Cu1
Cu2

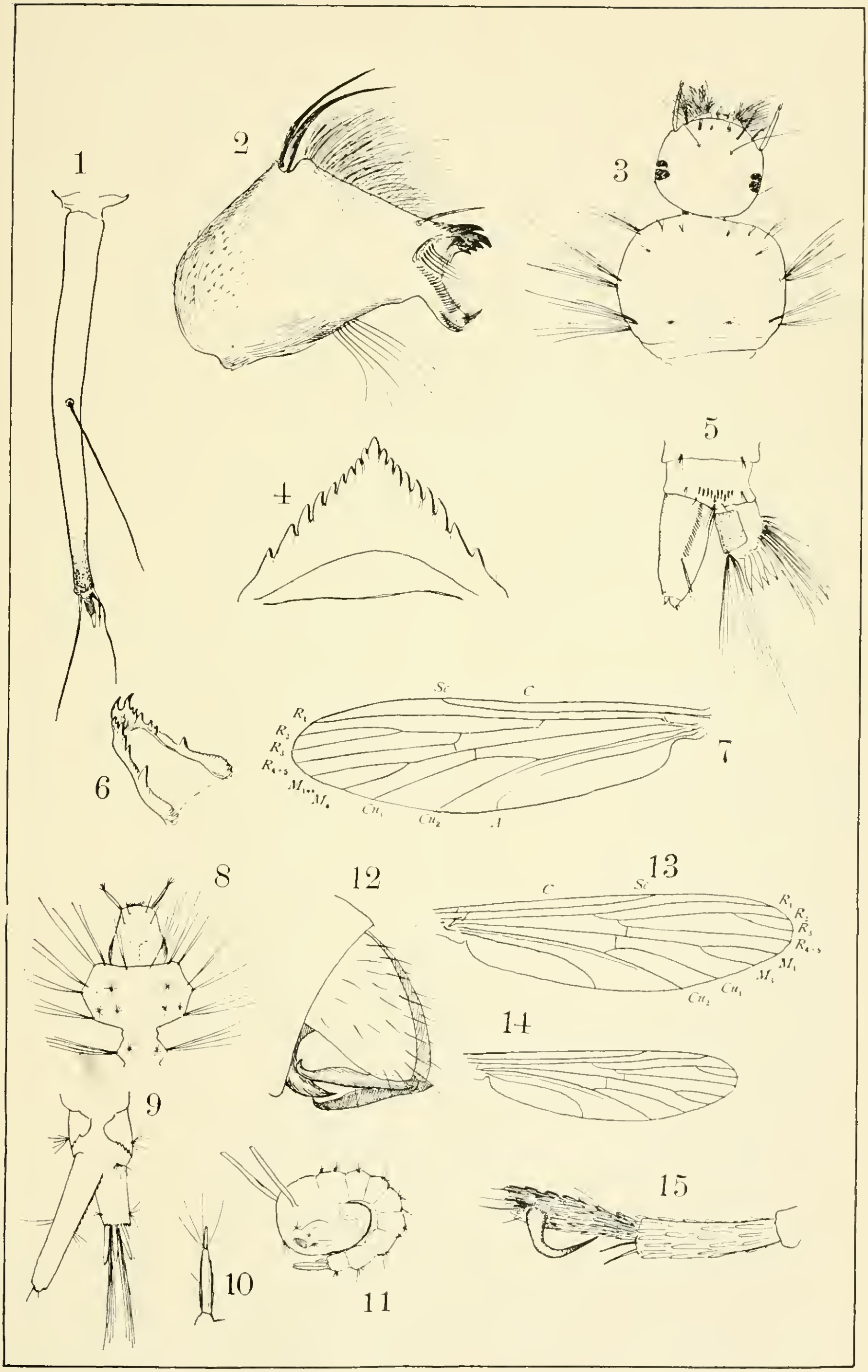
Culex pipiens


1
2
s
3
4
5
t
s
6
7
9
8
c
10
C
Sc
R_1
R_2
R_3
R_{4+5}
M_{1+2}
M_3
Cu_1
Cu_2
A
11
12.
13

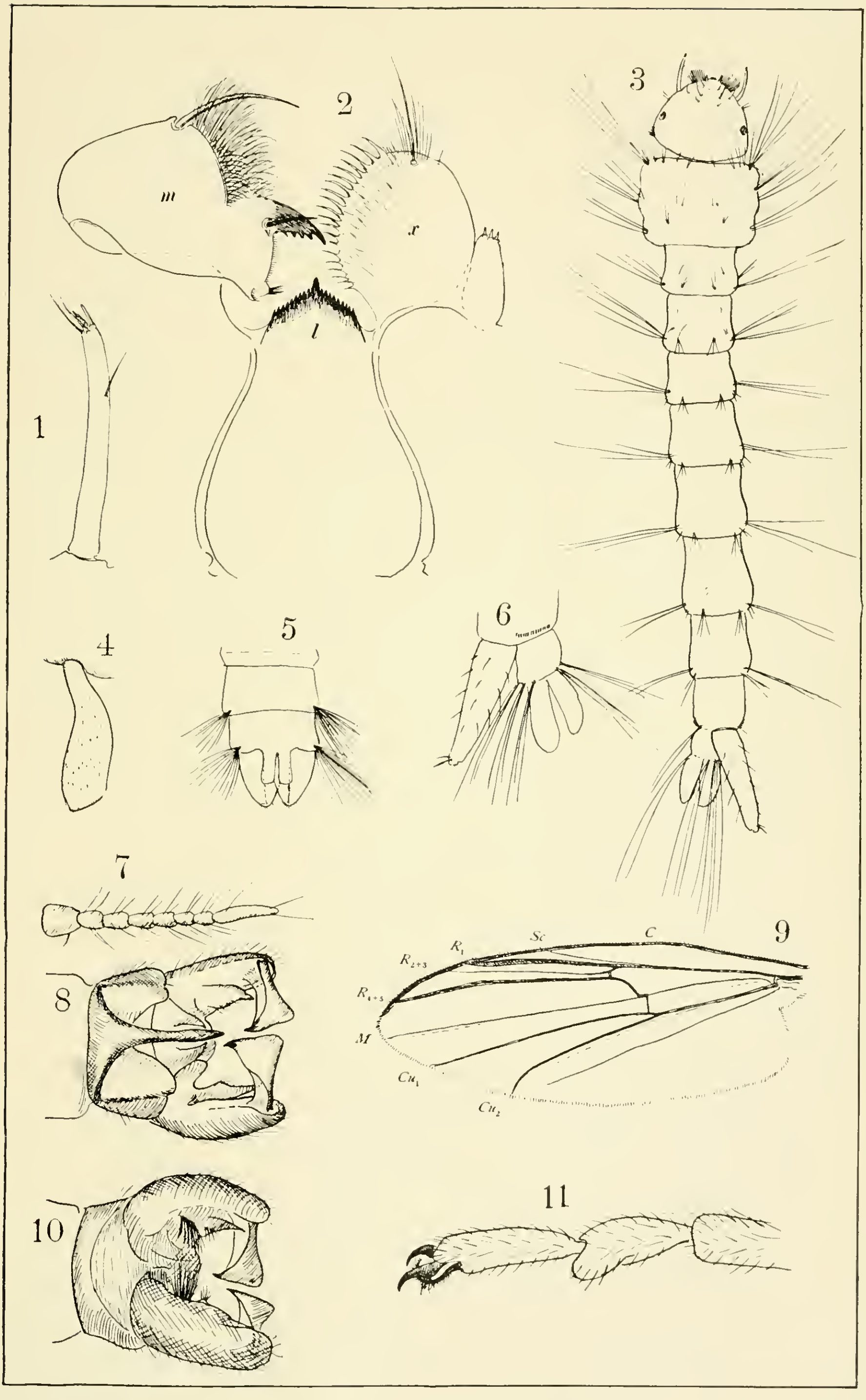
Culex restuans


1
2
a
3
4
5
6
7
8
9
10
Sc
C
R_1
R_2
R_3
R_{4+5}
M_{1+2}
M_3
Cu_1
Cu_2
A

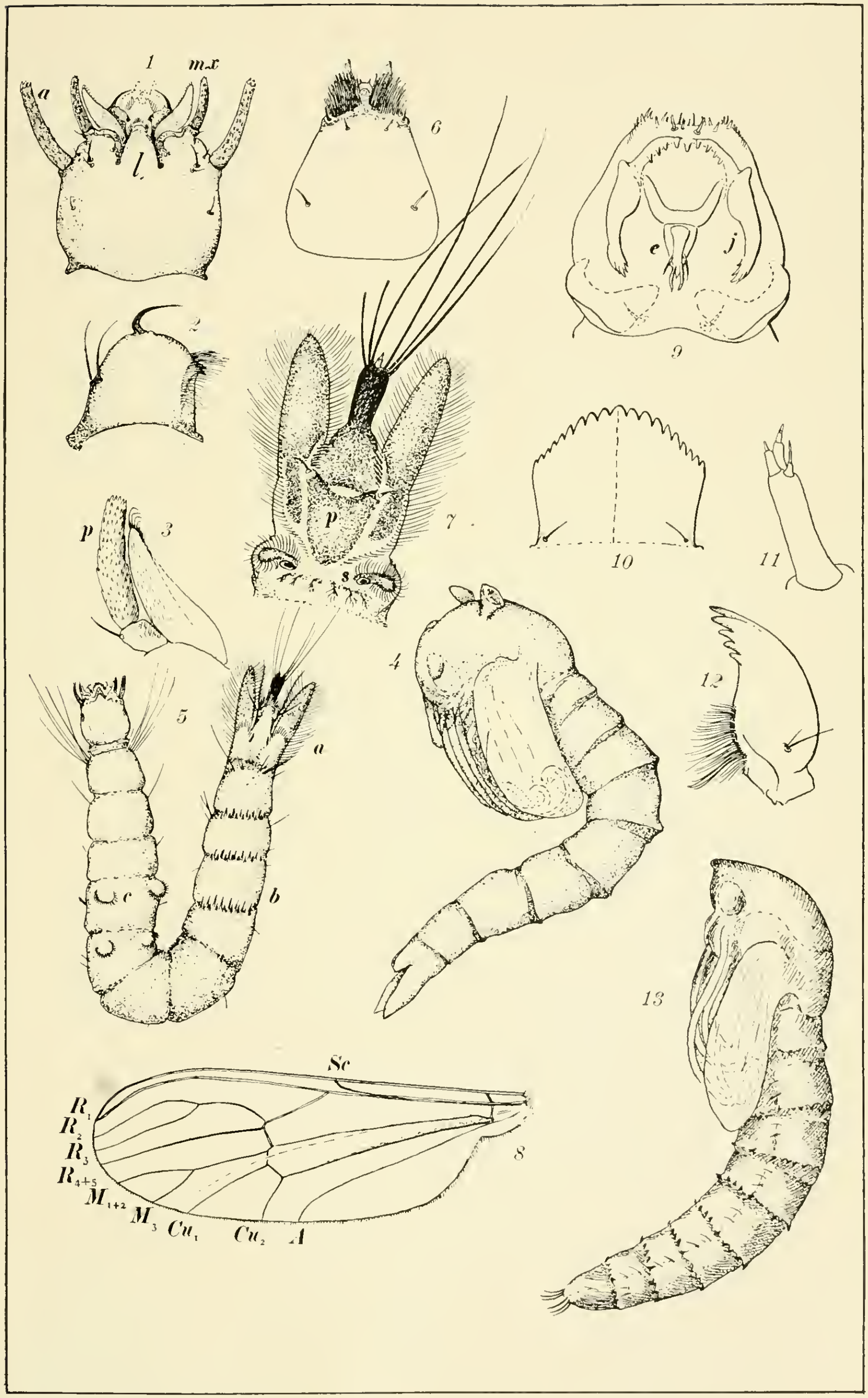
Culex cantans


1
2
3
4
5
6
7
Sc
C
R1
R2
R3
R4+5
M1+2
M3
Cu1
Cu2
A
8
12
13
C
Sc
R1
R2
R3
R4+5
M1
M3
Cu1
Cu2
14
9
15
10
11

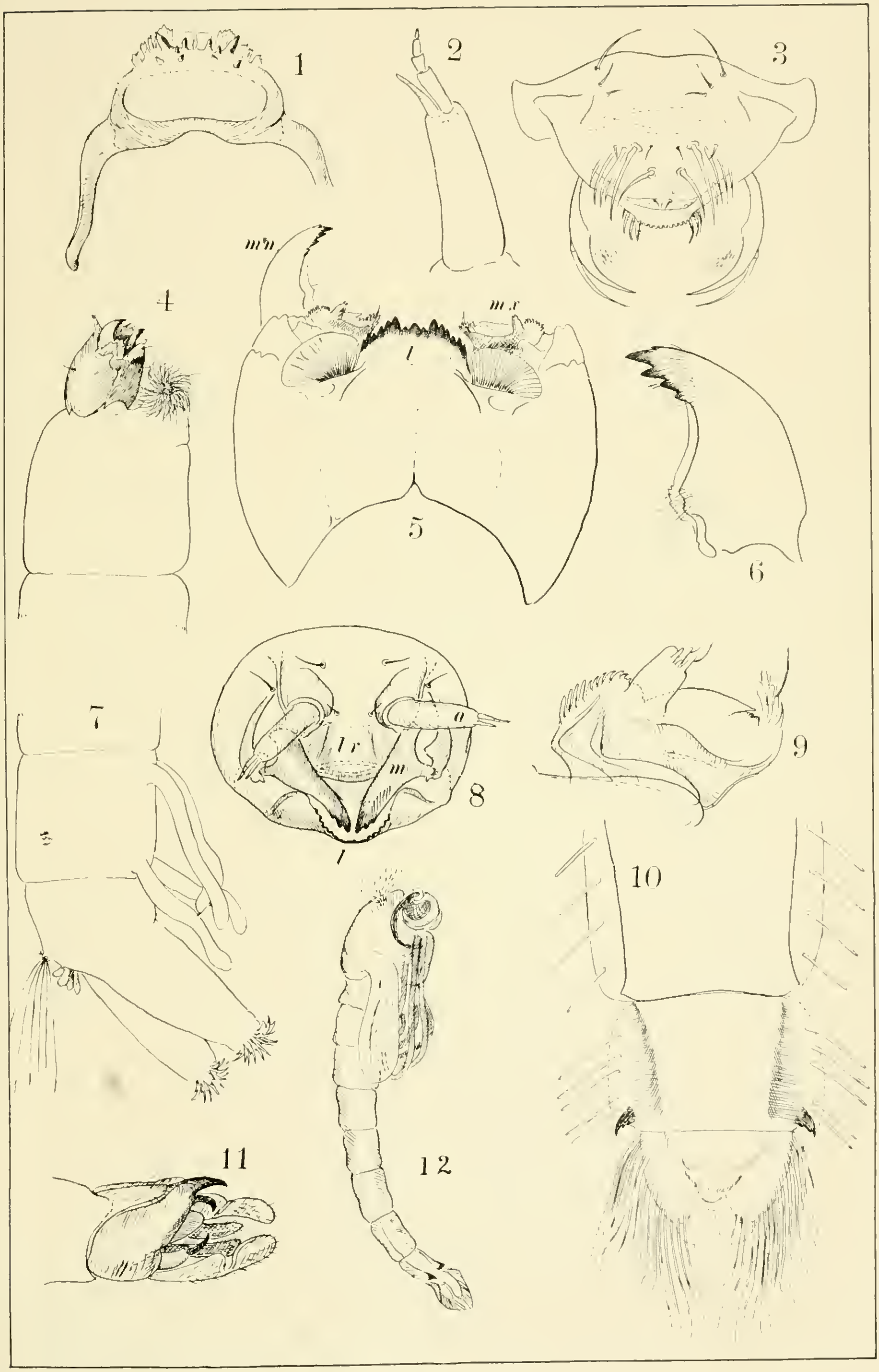
Culex triseriatus and Uranotaenia sapphirina


2
3
m
x
l
1
4
5
6
7
8
9
Sc
C
R_1
R_{2+3}
R_{4+5}
M
Cu_1
Cu_2
10
11

Aëdes smithii and Diamesa waltlii


1
mx
a
l
6
9
e
j
2
7
p
s
3
p
10
11
4
5
a
b
c
12
13
Sc
R_1
R_2
R_3
R_{4+5}
M_{1+2}
M_3
Cu_1
Cu_2
A
8

Dixa modesta and Diamesa waltlii


1
2
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mn
4
mx
l
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6
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lr
a
m
8
l
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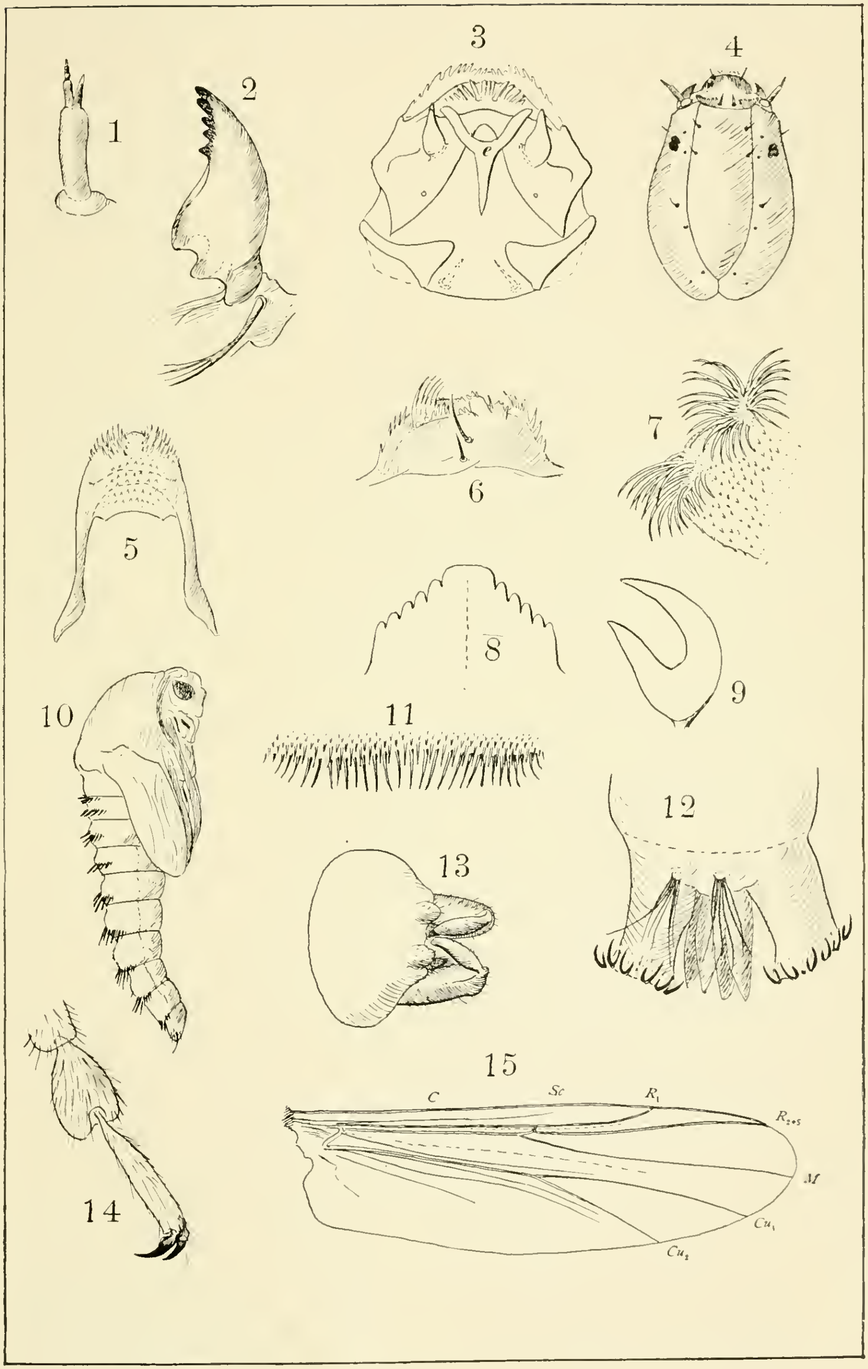
12

Chironomus


1
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13
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15
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R₂₊₅
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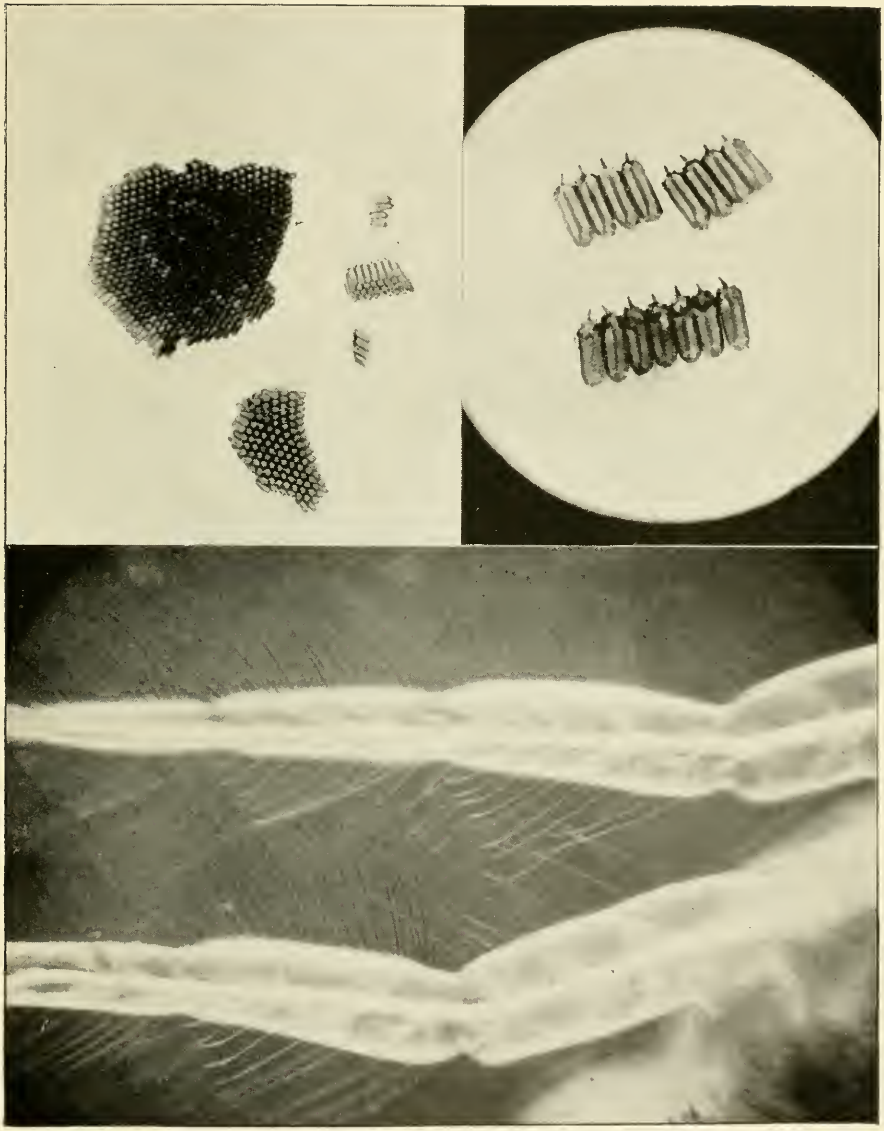
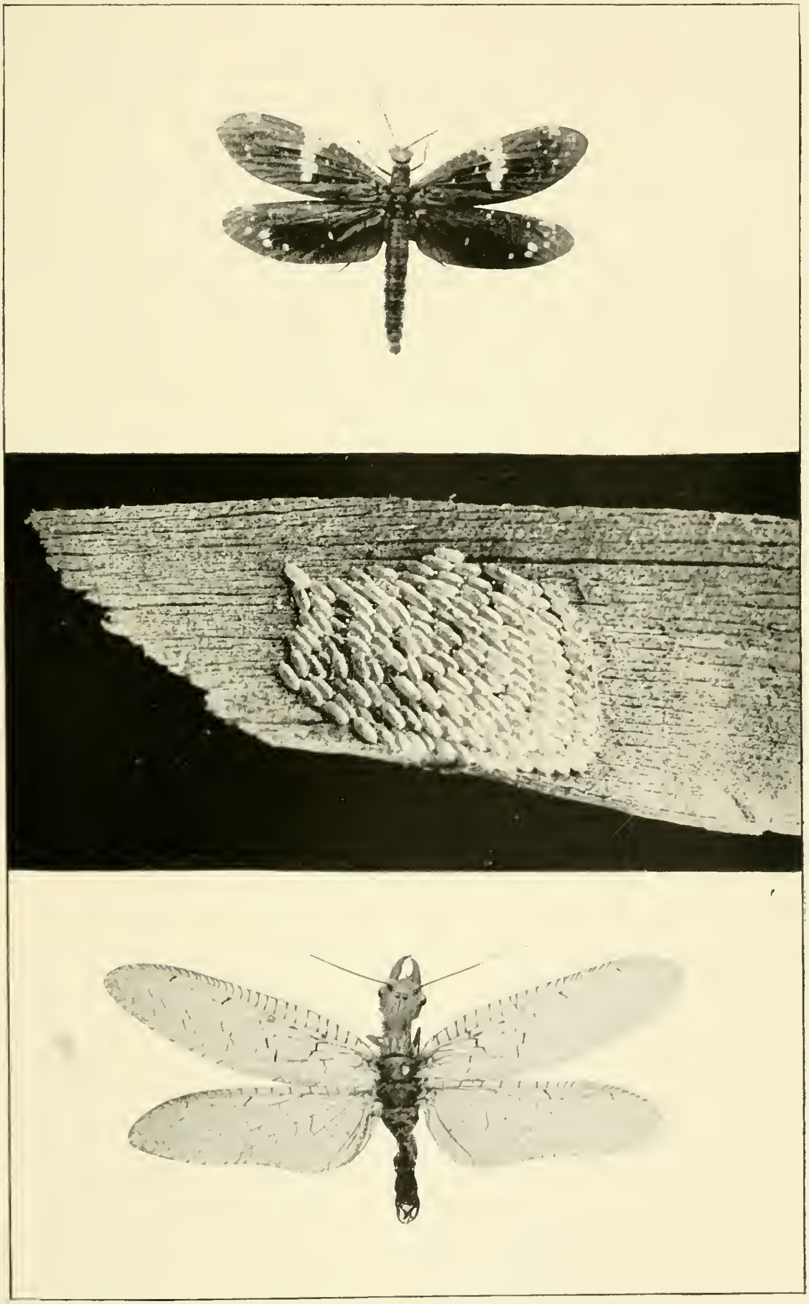
Cu₁
Cu₂

Thalassomyia obscura

Plate 51



Sialis infumata, eggs and lateral filaments



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Reports 2, 8-12 may also be obtained bound separately in cloth at 25c in addition to the price given above.

Botanist's annual reports 1867-date.

Bound also with museum reports 21-date of which they form a part; the first botanist's report appeared in the 21st museum report and is numbered 21. Reports 21-24, 29, 31-41 were not published separately.

Separate reports 25-28, 30, 42-50 and 52 (Botany bulletin 3), are out of print. Report 51 may be had for 40c; 53 for 20c; 54 for 50c; 55 (Botany bulletin 5) for 40c. Since 1901 these reports have been issued as bulletins.

Descriptions and illustrations of edible, poisonous and unwholesome fungi of New York have been published in volumes 1 and 3 of the 48th museum report and in volume 1 of the 49th, 51st, 52d, 54th and 55th reports. The descriptions and illustrations of edible and unwholesome species contained in the 49th, 51st and 52d reports have been revised and rearranged, and, combined with others more recently prepared, constitute Museum memoir 4.

Museum bulletins 1887-date. O. *To advance subscribers, $2 a year or 50c a year for those of any one division:* (1) *geology, economic geology, mineralogy, general zoology, archeology and miscellaneous,* (2) *paleontology,* (3) *botany,* (4) *entomology.*

Bulletins are also found with the annual reports of the museum as follows:

Bulletin	*Report*	*Bulletin*	*Report*	*Bulletin*	*Report*
12-15	48, v. 1	20-25	52, v. 1	35-36	54, v. 2
16-17	50 "	26-31	53 "	37-44	" v. 3
18-19	51 "	32-34	54 "	45-48	" v. 4
				49-54	55, v. 1

The figures in parenthesis indicate the bulletin's number as a New York State Museum bulletin

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G4 (48) Woodworth, J. B. Pleistocene Geology of Nassau County and Borough of Queens. 58p. il. 9pl. map. Dec. 1901. *25c.*

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G6 Cushing, H. P. Geology of the Vicinity of Little Falls, Herkimer Co. *In preparation.*

—— Crystalline Rocks of the Northeastern Adirondacks. *In preparation.*

Kemp, J. F. Crystalline Rocks of Warren and Washington Counties. *In preparation.*

Woodworth, J. B. Glacial Geology of New York. *In preparation.*

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